Journal of the American Foundrymen's Association.

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THE MOLDING MACHINE.

BY S. H. STUPAKOFF, PITTSBURG, PA.

JIGS.

The deduction arrived at in the foregoing chapter might make it appear that plated patterns are not likely to find an extensive use in jobbing foundries, whereas this is really not altogether the case. There is no doubt that plate molding in its present shape, or rather as ordinarily applied, is practically excluded from jobbing shops. But, if a plate is used in connection with a suitable jig, specially prepared for the purpose, objections are not only overcome, but the application and use of plates offer excellent advantages, even in such cases where only a small number of castings of the same pattern are required at one time. At best, the economic use of plated patterns is limited by the shape and size of the castings. The fundamental principle involved in their construction and application must be fully understood by the user, if satisfactory results are expected.

Irrespective of its relation to the molding machine, it would seem that this subject—on its own merits—is of such importance, that it should be investigated by all foundrymen. It should specially interest the majority of our members. I have therefore somewhat enlarged the scope of this treatise on the molding machine by including a detailed study of the construction and modus operandi of this particular contrivance.

To begin with, it should be understood that all plates are provided with guide-pin holes, which are accurately fitted to corresponding guide pins forming part of the flasks. Unless special flasks are used in connection with such plates the customary flask pins should not be confounded with these guide pins, as they will never answer the purpose. In order that mis-conceptions in this respect may be avoided, this term will be adhered to in what follows, and strict distinction will be made between

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flask-pins and guide-pins wherever they may be mentioned in the course of this work.

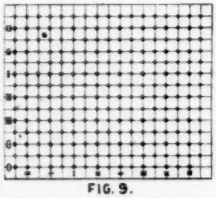

FIG. 9.

The guide-pin holes, G and G¹, Fig. 9, are preferably arranged on opposite ends of the plate, in even multiples of an inch, and equi-distant from its center and on a line dividing the plate into two equal rectangles. There are exceptional cases, in which three or four guide-pins must be used. The most serious objection against this arrangement is the greater difficulty experienced in locating the patterns correctly.

Accuracy in preparing the plates becomes of the utmost importance, as the magnitude of all errors occurring in the original laying out is doubled by each subsequent operation. The guide-pin holes should be drilled and reamed out at right angles to the surface of the plate, and it is advisable to provide them with hardened and ground steel bushings. All guide-pins should be of uniform diameter irrespective of the size of the plate. A pair of test pins should be kept on hand, which snugly fit the guide-pin holes; one-half of one of their ends should have been cut down to about ¾" in length, leaving as remainder *exactly* one-half of the cylindrical portion. (Fig. 7). If these test pins are inserted into their respective holes and a straight edge be placed against their flattened faces, it will serve for locating the base or the center line of the plate, for marking off and laying out the dowel pin holes, arranging the patterns and checking off all work relating to it.

The exact location of the center of the plate, and likewise the center of the flask, is found by dividing the base line from center to center guide-pin hole into two equal parts. Let us drill a hole C in this place, (fig. 8) and let this hole serve as the starting point for future operations. Now we will assume that we have procured a tri square with a row of holes drilled in each of its legs; these holes are spaced equally—say 1 inch apart—

care being taken that each row stands exactly in a straight line, and that both rows include an exact angle of 90 degrees. We place this square in such a manner on our plate that the hole in its apex corresponds with the center hole C of our plate, and insert a good fitting dowel pin through both. Thus we are able to shift the square over the whole surface of the plate by turning it around the center pin. Next we bring one leg of the square over the base line of the plate and insert a second dowel pin (which may be shouldered if necessary) through G into the corresponding hole of our square. Secured in this manner the square should be absolutely rigid and should not shake to right or left on the surface of the plate. We now drill one hole each into the plate through the guides H and I of the square, then we remove the pin from G, turn the square around the center pin over 90 degrees, so that one of its legs points upward and the other one to the left, insert a dowel through the hole in the leg pointing upward into the top hole I^1 of the plate, and drill the hole H^2; finally we turn it again over 90 degrees, secure it in the same manner as before, and drill the hole I^2. Figure 8 illustrates the square in the first position as located on the plate; the holes H^2 and I^2 which are drilled subsequently, are shown in faint lines. We shall call these holes, in the future, "pilot holes," in order to distinguish them from others in the same plate. These four pilot holes include an exact rectangle or square, and each opposite pair is located at uniform distances from the center of plate and flask. It will be understood that it is not absolutely necessary to employ the square for drilling the pilot holes. For instance, after one plate has been prepared in this manner, this plate can serve as a jig for drilling any number of additional plates in the same manner by a single setting. Such an original or master plate is especially serviceable, if all holes are provided with good steel bushings. The pilot holes in connection with the center hole will serve us hereafter as guides for locating pattern dowels.

Our object in view is to use this plate as a base for any and all suitable patterns, and as an illustration we will arrange it for the reception of patterns of a globe valve and a bib cock. We will assume that the patterns are all in good shape and properly parted. However, they shall originally not have been intended for use with either molding machine or drawplate. Our plate

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and flask are of a suitable size, but the job is in a hurry—as all jobs are—and we must get out quite a number of these castings to-day. What are we going to do about it? Take my advice and make it in the old fashioned way, unless you are provided with a suitable jig plate and an inexpensive, but a good small drill press, which was never used by your blacksmiths or yard laborers, but was expressly reserved for this purpose only, was always under the care of a mechanic who understood *how* to handle it, and who took pride in keeping it in good shape.

This jig plate (fig. 9) should be provided with a number of holes, two rows of which, at least, are drilled exactly in the same manner as those in the above mentioned square; the balance are laid out preferably, but not necessarily so, in straight and parallel lines, all equi-distant from each other. Its dimensions should be sufficient to cover one corner, or one-fourth of your pattern plate.

If these things are part of your equipment you will have easy sailing, and you will be better fitted to tackle the job than your competitor.

Place this jig in such a manner in one corner of your draw plate that the hole O (fig. 9) corresponds with the hole C in its center, hold both together with dowel pins inserted into the pilot holes, and drill the holes through the jig into your plate, which are required for securing the patterns in the predetermined places. To avoid mistakes be sure that the hole in that particular corner of the jig, which corresponds to the one described as located in the apex of the square is distinctly marked on both sides of the jig plate—in our figure marked O—and note carefully which holes in the jig were used for drilling the dowel holes into the pattern plate. Thereafter turn the jig upside down on the pattern plate, insert the dowel pins again through the same holes O and OI into C and I^1, and the third one through OH into H^2, and then, as before, drill through the same guide holes of the jig the corresponding dowel holes into the second quarter of the pattern plate. Repeat the same process at the lower half of the plate, being always careful that C and O remain together and your plate is ready to receive the patterns.

That there may be no doubt as to the method of operation, I suggest that you will refer to the two plates which are attached

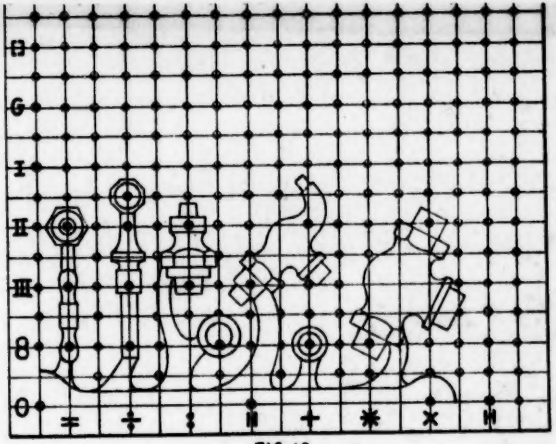

FIG. 10.

fig. 10.

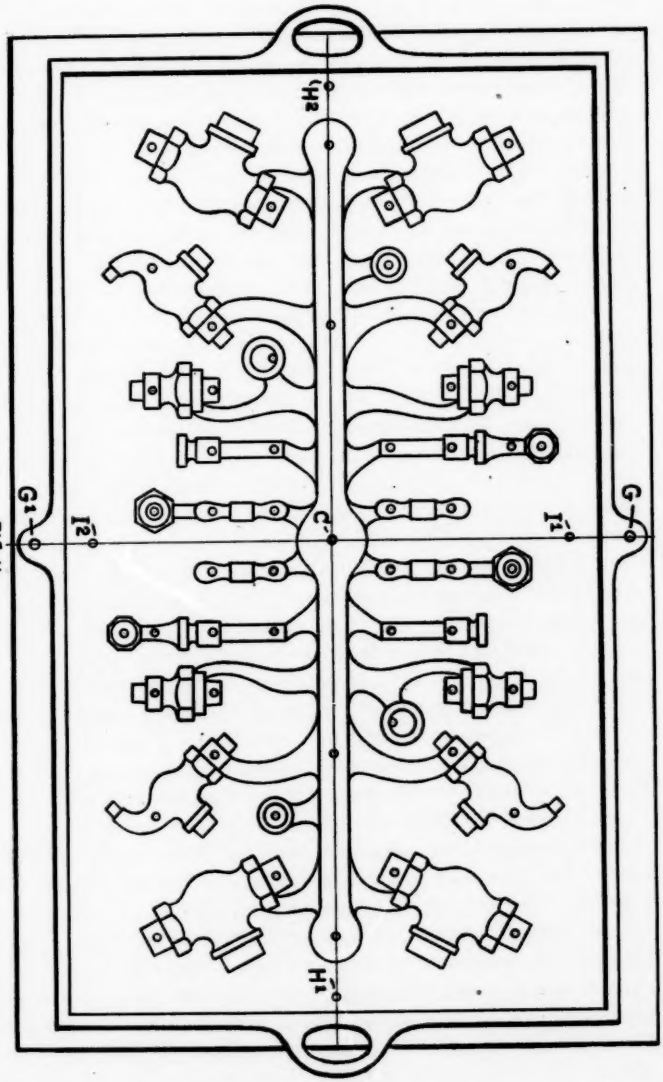

FIG. 11.

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hereto, one of which (Fig. 10) is made on transparent—so called "onion skin" paper. The cut on the latter represents the jig. In faint lines thereon is shown the outline of the position of patterns, which corresponds to the arrangement of the same on the pattern plate (Fig. 11). Horizontal and vertical lines, which are provided with identification marks, cross all the holes in the jig plate. The holes which are to be used in this special case as guides for drilling the necessary dowel pin or screw holes in the pattern plate are indicated by circles drawn in heavy. Thus, the holes II × and 8* are used for securing the globe valve body pattern, II + and III || for the body of the bib cock, and so forth. By placing the onion skin in such a manner over the drawing of the pattern plate, that its hole O corresponds with the center hole C of the latter, and OI and OH respectively with I^1 and H^1, it will be noticed that the outlines representing the patterns cover each other in both cuts. The jig placed in this position over the pattern plate, and secured to it by the pilot pins at O, OI and OH is used in this manner for drilling all dark lined holes in the right hand upper corner of the draw plate. This being done, the pilot pins are withdrawn and the jig plate is reversed and turned into the upper left hand corner of the pattern plate, just as if it were hinged at the line OI, the pilot pins are replaced into the same holes of the jig as before and in this position they will secure it to the pattern plate by entering its pilot holes C, I^1 and H^2. It will be observed that in this position also, and equally well, the outlines of the patterns in both cuts fall exactly together. The jig is used in this position as before, the same guide holes which were used in the first position in the upper right hand corner serve again as guides for drilling the second quarter of the pattern plate. Identically the same process is then repeated at the lower left hand and lower right hand corners of the plate, by first turning the jig plate around the imaginary hinge center OH, and then around OI.

In order to prepare the patterns to suit the above conditions, we proceed exactly in the same manner, by securing one-half of each separately, and always the one which has the dowel holes, at the previously determined place on the jig plate and drilling clear through them the holes which coincide with those drilled previously into the pattern plate. The second halves of these pat-

terns are then placed in position against the first (drilled) halves; they are prevented from moving sideways by their original dowel pins, and they may be held together by suitable clamps. These clamps are preferably made of a universal type which adapts them for use with all kinds of patterns, their lower portion being constructed in the shape of a frame which rests on the table of the drill press without rocking and which is adapted for fastening the patterns in such a manner that their parting faces stand parallel to the drill table. The half of the pattern which has been drilled first with the aid of the jig occupies the upper position in this clamp or drill frame, and the holes in this one will now serve as guides for the drill to drill the holes in the second half which stands directly underneath. Finally have the original dowel pins of the patterns removed and fasten all parts separately in place on the pattern plate by either dowels or screws, or both, which ever may be preferable and most convenient in your particular case.

If I may call your attention again to the drawings, you will observe that we have prepared the pattern plate in this manner with four complete sets of patterns; yet, we have used only two. The castings resulting from the use of these plates should be perfect as to match. The amount of labor required to withdraw the patterns from the sand is reduced to a minimum, additional time is saved by the use of a stationary gate or runner on the plate, and double the quantity of castings can be produced in this manner with the same number of patterns and in the same number of flasks. All this can be accomplished by making an effort of no longer duration than it took to describe.

If you have followed the above description carefully, you may have noticed that it is not necessary to have an individual plate prepared for each set of patterns. Yet I thought it better to describe this method of preparing pattern plates and patterns for plate molding in detail, than to leave room for any doubt or error. You can easily see that much of the time which it apparently took to get the plate and patterns ready for the molder, can be saved by providing the entire surface of the plate with dowel holes before putting it into use. This should be done with the aid of the jig and in identically the same manner as has been sufficiently explained in the foregoing. Thus, only new pat-

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terns have to be prepared for the purpose, and all others, which once have been fitted, are easily replaced and secured to their correct positions on the plate, providing their dowel holes were promptly provided with specific numbers, letters or identification marks. The additional holes in the plate will not impair its working qualities, but they could be easily closed up with beeswax if objectionable. Finally, it is well worthy to note that each plate can be used in connection with all patterns within its range, and that it can be kept in continuous service, while the patterns may be changed at will, and as often as desirable.

While the above description may appear somewhat too extended, I assure you that a serious mistake would have been made had the subject been slighted merely for the sake of brevity. At the same time I will say in justification of my apparent digression, that my original subject has not been sidetracked. At first sight, it may appear, that the construction and the manipulation of pattern plates has but little connection with molding machines, but I hope that I will succeed in showing in the course of this work, that they are not only intimately connected with each other, but that they are in fact the principal parts of all molding machines. The lack of intimate knowledge of how to make use of them to the best advantage, the want of proper means to effect this purpose and the wretchedly little effort which is made to catch the right spirit of their nature is generally the reason why a molding machine becomes an elephant on the hands of a molder and an eye sore to its owner.

FIG. 7.

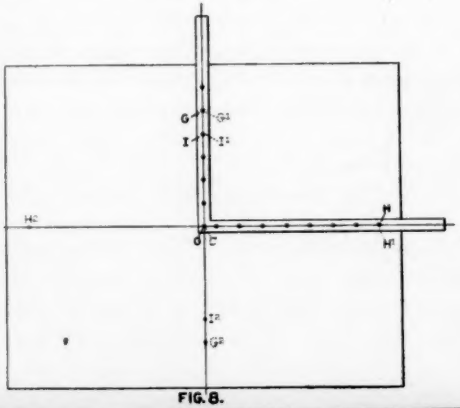

FIG. 8.

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FLASKS.

Talk to a foundryman about flasks and you will touch another sore spot. No wonder, for flasks are a continual drain on the exchequer. Founders will tell you that if it were not for the cost of flasks, there might be some profit in the business. They admit that they are are a necessity, but invariably think them an unavoidable nuisance, a source of constant annoyance, loss, and expense, and in fact the greatest evil of the foundry. It is often thought that every cent spent on the construction and maintenance of flasks is just so much money thrown into the gutter.

But luckily, all the opinions on this subject do not run in the same direction. There are many founders who have gone through it, who hold and prove that bad flasks give bad results, are false economy, and point to poor judgment. They argue, and justly so, that money spent judiciously for a good flask equipment, especially for a good set of stock flasks, and a liberal sum set aside and used for their maintenance, is a good investment. An expenditure of this kind is mainly a matter of first cost, and is fully justified by the results.

The founder who knows a good thing when he sees it, will also know how to take care of it. He will not permit his flasks to be abused and thrown out into the yard where they are exposed to the deteriorating effects of the weather. He will keep them under roof and guard them against all possible damage. Nobody will question the fact that bad flasks are more than likely the principal cause of loss of time and of castings. Yet how many are there who will anxiously try to save and stint in this direction? Give your molder good material, good facilities, and above all let him have good flasks, and you have a right to expect a good day's work, and that of good quality.

Good flasks are especially important in machine or plate molding. In fact, to insure good results from molding machines,

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the flasks used must be practically perfect. They should be constructed so as to insure a firm holding of the molding sand. They should be made stiff, light, and durable. The flask pins should be accurately fitted. If flasks are made in sets, they must be absolutely interchangeable. When copes and drags are put together they should not rock or shake sideways. The pins should be firm and square with the flask surface; and while they must not bind on the other hand they must not fit too loosely.

Ordinary shop-made wooden flasks, such as are used in most foundries, are not likely to give good results in molding machine practice, but if carefully and substantially made, and perfect in all other respects, there is no reason why their application in machine molding should be absolutely condemned.

Iron flasks are always preferable, more especially because they do not shrink, warp, or get out of joint. Pressed steel flasks, if they could be procured, would answer still better. If wooden flasks are used, they should be provided with an iron ring, at their face, which ring should serve not only as a tie and alignment, but also as a base for securing the flask pins.

FLASK PINS.

Turned tapering flask pins give the best satisfaction in flasks for machine molding. Part of the pin is usually turned down to a square shoulder with a thread at its lower end, the cylindrical portion is fitted into a corresponding hole in the flask lug and permanently secured thereto by a nut. A better way is to ream tapering holes in the flask lugs, make the lower ends of the pins accordingly and drive them lightly into place. Thus, a few pins will answer for any number of flasks, as they can be removed as soon as the flasks are closed and clamped together. Greater care can thus be bestowed upon their production, as the increased cost is but a small item, and when not in use they can be easily removed from their sockets and bolts, flasks and pins can be easily and properly taken care of.

A convenient way to remove such taper shank pins is shown in Fig. 12. A piece of flat iron or a flask clamp is used as a lever by placing it between the lower end of the taper shank and

the rounded top edge of a fulcrum lug, which may form a part of the side of the flask, and which should be located one or two

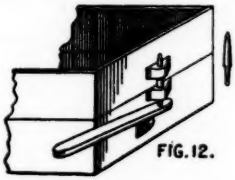

FIG. 12.

inches out of alignment with regard to the center line of the flask pin. A prolongation of these lugs may also form the handle of the flask. A slight pressure or a light tap with the hammer will loosen the pins from their sockets, whereupon they may be easily withdrawn. The B. & S. Standard is recommended as the most suitable taper for those taper shank flask pins. Accurate reamers are always obtainable in exact duplicates, and their use insures absolute uniformity.

It may not be out of place to caution against the maltreatment of the ends of these flask pins, which is bound to cause trouble and annoyance. There is not much likelihood to injure the pins if mallets of either rawhide, wood, lead or copper are used for driving them in or out. As an additional precaution, to protect them from injury it is desirable to have them case-hardened. Care should be taken that the flask pins do not spring or bend during the hardening process, if they do, this fault should be corrected before they go into service, for bent or sprung pins are unfit for use. Little or no trouble will be experienced with good tool steel pins.

It is common practice to arrange the flask pin lugs in such a manner that a space of about a quarter of an inch or more is left between them when the flask is closed. Thus, no attention need be paid to the small quantity of molding sand, which inadvertently collects and packs around the base of the pins while the flask is being filled, but which would otherwise form an obstruction in the closing up of the flask. These spillings must be removed if the faces of the lugs are on a level with the parting edge of the flask.

It is sometimes troublesome to close or open flasks which are provided with well-fitting round flask pins, as molding sand

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or dust will unavoidably adhere to them. This difficulty may be overcome to a great extent by removing a portion of the cylindrical part of the pin by either flattening or grooving as shown in the cross section. Fig. 13.

FIG. 13.

Constant use of flasks of this kind will eventually wear out not only the flask pins, but also the sockets of their corresponding mates. They cannot possibly be kept absolutely clean, and the sand will keep on cutting until the defect must be remedied. It is an easy matter to exchange the worn out pin for a new one, but it is not so easy to correct the fault in the flask pin socket, unless, indeed, it was provided with a removable bushing in the first place. This, when necessary, can be replaced with the same facility as the pin. This is a point but rarely observed. To get perfectly satisfactory service out of a flask, it is nevertheless quite as important a matter as all the others which were mentioned above.

The makers of molding machines are undoubtedly very well aware of all the requirements, which are covered by the observance of these little details; they will appreciate their importance and must admit that they are essential to make their machines a success. Yet, to my knowledge these facts have never been mentioned. Is this information kept from the founder purposely, that he may not be scared from the purchase of machines? If he should be told all this he might in the first place think of the expense, and next that his molders cannot get used to refinements of this kind—which, by the way, is not a very creditable opinion. But, if he buys one or more of the machines offered he cannot help finding all this out before long, to his own chagrin. By that time, perhaps, he has made up his mind to throw the thing in the scrap pile, or, if he persists, because he knows that others have succeeded, he will be compelled to pay dearly for his experience. He could have had this experience in the first place, and at a reasonable price, had he been furnished not only with the machine, but at the same time with jigs, sample flasks, pins,

etc., and above all with necessary information to which he was justly entitled.

It should be taken into consideration, that not all founders, foremen and molders are expert engineers or machinists, nor can they be expected to be fully versed in all the intricacies of machine design, mechanical laws and movements. To convince them, and to demonstrate that machine molding is superior in every respect and more economical than the process of hand molding, in which line they themselves are experts, they need all available assistance and must be taught from the very beginning the principles of the construction of the machines, the scope of their utility, their application and the importance of accessories, and the essential parts in all minor details. Many failures to introduce the molding machine into foundries, to establish and to maintain their reputation as labor savers can be traced to the lack of intelligible instructions sent with them by their makers, and be it intention or neglect, the witholding of this information does more or less harm to all parties interested, and retards the world's industrial progress.

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SHOP CONDITIONS.

BY HUGH MCPHEE, BRIDGEPORT, CONN.

Taking the average foundry of the present day, generally speaking, we find conditions existing that are not creditable to either employer or the foreman in charge. A lack of interest, it seems to me, is the cause of this. The molder and apprentice, in my estimation, should not be held responsible for this, for we find that the improvements in all the other departments of great manufacturing concerns result in benefit to both employer and employee. Unfortunately these results are not met with in the foundry. Not that less work should be done, but ways and means should be provided to increase the efficiency of a shop. This, I think, can only be done by a combined effort on the part of the employer and his foreman to make the conditions such that the employee can have a place to work in that will give him heart and interest to do better than he ever did before.

Take the molder who commences at 7 A. M. As he strips for work, he hangs his clothes on a spike driven into the wall as near his floor as may be convenient. Many times these clothes drop to the floor, and no one bothers with them. Now he finds his flasks shook out during the night, but must tear the castings out of the sand, wet this down, get his shovel and temper his sand pile so that he can commence to mold.

By the time he is ready to mold a day's work he is played out, but by dint of practice and the necessity of doing so, he labors on with only one outlook before his mind—quitting time.

Now we know that things are usually severe enough to bear even with the best of conditions, for we all have had more or less of just this experience. Believing that a remedy is absolutely necessary, let us look at the conditions prevailing in the machine shop and the pattern shop. A machinist has a specified machine to operate, with helpers conveying the castings to be finished to him, keeping him supplied with material to perform

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his share of the production. Producing finished work gives him an interest in it which is of benefit to his employer.

The same holds true in the pattern shop. The pattern maker has a bench to work at. His lumber is brought to the shop, laid down convenient to the saw and planer. He can get his material without any special exertion; in fact everything is placed for him in such a way that he has only to perform the work that his trade demands.

Now, why cannot we have some such conditions existing in the foundry. This is in itself a less desirable place to work in on account of the dust and dirt. Have a place for each man to hang up his clothes in, so that he can wear good ones. Have his floor in the same condition as the machinist has his—ready to begin work on. Let helpers prepare his sand pile so that he can commence molding and not act in the capacity of a laborer the first two hours of the day. Let his castings be shaken out for him, his flasks be fixed up. He can then put in eight hours molding instead of six, and get out superior work and much more of it.

May this effort to present the subject in a somewhat different light, result in awakening the interest of my foundry colleagues, and that some action be taken toward the improvement of the conditions surrounding the molder. Then the trade will receive greater recognition everywhere, and stand second to none.

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CORES AND CORE ARBORS.

BY EDWARD B. GILMOUR, MILWAUKEE, WIS.

In the upbuilding of our language it has been customary to give names to the things pertaining to science and art, such that on hearing them mentioned, a good idea of them is obtained, even though they have never been seen. Thus in foundry practice we ask what does a founder "found?". From this comes the subdivision into iron founder, brass founder, etc. Similarly the world "mould" conveys the idea of shaping something into a particular form as may be wanted. In speaking of cores one naturally recalls the well known quotation from Shakespeare, "Give me the man that is not passions slave, and I will wear him in my heart's core."

The core is a very important part of a mold, but in a great many cases is dismissed with the idea that all that is wanted is simply to ram sand in a box to the shape desired, and you have the core. This may be so, but unless the core is properly vented, that is proper channnels provided for the exit of the gases that are generated while casting, the result will be a bad casting. The gases will be forced through the surface of the core and blow the iron out of the mold. In many cases the core will go to pieces, and so you will readily see that core-making plays a very important part in the production of good castings.

Cores are made in different ways and with various materials. The usual method is to dry them, for when a core is thoroughly dried there is less liability of anything going wrong. There are other cores that are used "green" that is not dried, and must be made of a different material from that used for the usual dried core. When a boy goes to work in the foundry for the first time he is taught the art of core-making, beginning with very small cores, afterwards branching out into the larger ones. This is

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the first work of molding, and all good molders are, as a rule, good coremakers.

It is usually the practice to make a core-box of the final shape desired, but in many instances guides or templates can be used to great advantage when only one core is required. All cores must have an arbor or rod. These arbors can be made exactly to fit the core in every particular. Take for instance the crown core of a marine cylinder, as represented in Fig. I. The

CORE ARBOR
FIG. I.

usual method is to use a portable spindle and a sweep which is made for the bottom part of the core. The thickness of the core is cut out of the sweep and fitted back with strips to hold it in place when the bottom part of the core is swept up. Or, as we might call it, the core box is made as you would build a regular loam mold. Fig. 2. The strips are then taken off and molding

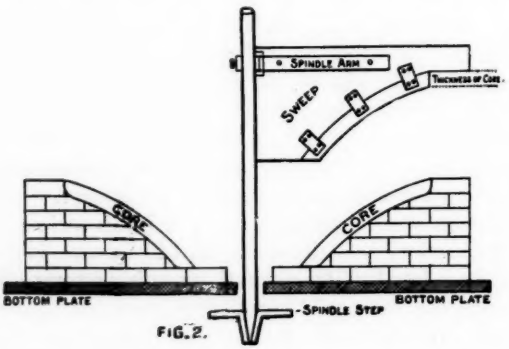

FIG. 2.

sand is rammed into the core-box and swept the shape of the top of the core. Now take a gate-cutter or piece of tin plate,

about four inches square, double over into a U shape and use this to cut out the mold to the desired shape, afterwards using a stamp in order to make the mold more regular. Also get a "Dauber" and insert into the mold every four inches apart, and get strong paper, cut it into V shaped strips to cover all over the mold. Fill the centre in with sand up to four inches above the top, with the usual gates inserted in order to run it. Straighten over the top and put a flat plate of the size required, on top of the sand, and bolt down to the bottom plate.

This is a very economical way of making difficult core arbors and can be utilized for any strength required. When the casting is made these arbors can be very easily broken out, on cleaning, and the iron used again as scrap.

The same kind of an arbor can be used in a great variety of work, such as the port cores of marine cylinders, and the cores of locomotive cylinders. I have used them to advantage and with economy, and personally brought the cost of locomotive cylinder cores twenty-five per cent. below the usual method of loose rods, besides having a better and safer core. The method adopted was to make a rough wood template in the shape of the core required, afterwards to make a mold the shape of the template, then cut out and stamp the arbor to the strength required, cover the mold with paper and fill over with sand. In making core arbors on this system they can be of any desired shape, no matter how intricate they may be. It is sometimes very desirable to make cores in green sand, especially when castings are very thin, as in a great many instances it would be impossible to get the core taken out before the contraction of the casting had taken place. Cores made in green sand are soft and yield readily to the contraction.

Another great advantage derived from the use of these cores is that they are very easily taken out and you can use the same material over again.

I at one time had a number of castings to make of the following description: A shell 2 feet by 2 feet 6 inches by 4 feet long and one-half inch thick. It can readily be seen that to use a dried core for a casting of this kind would be folly, as the casting would be cooled and fully contracted before the core could be taken out. The following method was adopted: An arbor was

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made, as shown in Fig. 3, the end bars were made one inch deeper and were planed perfectly straight so that they rested upon the

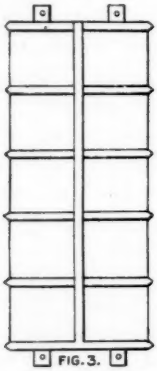

FIG. 3.

bottom of the core box. In the flask two bars were bolted the same distance apart as the bars on the arbor, so that when the core was placed in the mold the bars rested upon each other and made a very solid bearing. Holes were put in the lifting lugs in order to bolt the core to the bottom board, which had an iron strap screwed on the full breadth of the flask with holes right below the ones in the arbor. The object in having the bars planed off was that when the core was placed in the mold it would be perfectly square, as these bars in the flask rested upon the core prints of the pattern and an arbor of this design is so strong that it is impossible for it to twist in any way. If a green sand core should get twisted it is liable to crack, and should a crack occur in a core of this kind the casting would blow up when being cast.

In making a core of this kind it is good practice to put a sheet of newspaper on top of the cinders in order to keep down the pressure of the gases generated while casting. In making a green sand core of these dimensions there is a great pressure of gas inside of it, and unless great care is exercised in its production it is very liable to burst through the outer surface. The use of paper is suggested in order to keep down the pressure and expell the gas through the channels prepared for it.

Upon another occasion I found green sand cores of great

advantage. We had to make a large number of columns, having an 8-inch square core running clear through them. These columns were 14 feet long, and we simply made a box grate, Fig. 4. For the vent we had inch rods rammed in the ends of the

FIG 4.

grate. These rods were put in from each end right through the centre of the core as shown, the rods being about 1 inch apart at the centre, the object being to allow the gas as it is generated to go freely off. If the rods were continuous, the gas as it is generated would travel back and forward until the pressure would become so great that when it was ignited it would explode and would in all probability shatter the core, making a defective casting. The object in making this core in green sand was that when the casting was to be cleaned it was simply lifted on end with the crane and struck a few blows with a sledge hammer. The core came running out and the arbor was saved for the next one. Not only was there a saving in the cleaning of the casting but also in the material.

In foundries that a large number of pipe connections to make, and which entail a great expense in pattern making, especially as in the majority of instances, these patterns may never be used again. The principle that was adopted was to make

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iron segments $3\frac{1}{2}$ inches wide, the inside being the size of the core. A quantity of all sizes were kept in stock so that whenever pipe was ordered there was always the size on hand that was needed. In order to get the required shape there was made a rough wooden template of the size through the longitudinal section of the pipe. The first operation is to dig a hole in the floor in the shape of the template, the segments and flanges are next put into the hole and the template placed on top. The flanges and segments are arranged to the desired shape, the sand made up to the inside of the segments, which will be as a core box for the pipe when completed. The core arbor is next placed inside of the mold and the green sand core rammed up right inside in its place. Now match the other half segments and flanges on top of the lower halfs, so as to form the upper half of the core, but put the sand on the outside of the segments so as to form a pattern for the casting thereafter. Make the cope on top and when completed lift off. Then take away the top segments and cut the thickness between the segments. Lift out the core by the three points marked on Fig. 5, cut out between segments in mold and finish as usual.

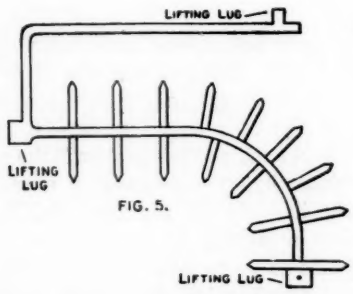

FIG. 5.

A core arbor made on this principle requires no anchor or chaplet below the core, but there must be one on top so as to hold the core in its proper place when the pressure is put on in casting. In setting the core arbor into the mold to make the core, it is necessary to put a solid bearing below the three lifting points so that when the core is put back into place there

will be no danger in crushing the mold.

The cost of producing pipes by this method is as cheap as if there was a solid pattern, and there is a great saving of material. There is no limit to the size of pipes which can be made by this method.

Another way which is very convenient for making special pipe connections, which are considered small, is to make a gauge as shown in Fig. 6; also a sweep as in Fig. 7. Make two half

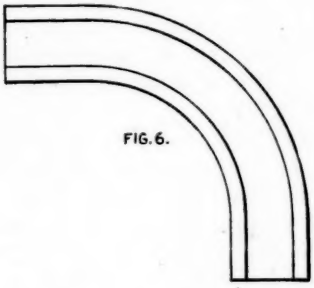

FIG. 6.

FIG. 7.

cores, and when dried sweep the thickness on each half. In molding lay one half on the follow board, ram up, roll over, and place the other half core on top; make the cope, and when completed take the core out and send back to core room in order to have the two half cores pasted together.

In making cores for straight pipes, such as water pipes, they are usually made upon corebars, or spindles as they are termed. Sometimes these bars are cast hollow, with holes dispersed all over them, in order to allow the gases to escape when casting. For small pipes ranging from 3 to 4 inches in diameter, a round, solid bar is used with grooves or slots running from each end so as to serve for the air passages. These bars are usually revolved by power, the bars having trunions on each end which fit into a bearing box. A cap fits over them so as to keep the trunion in place when in motion. Hay ropes are wound around the bar, and afterwards common black mud is swept over the ropes. This is termed the first coating. Thereafter the core runs upon a double rail into the drying oven and keeps revolving slowly

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through it to the opposite end. It is taken out by the man who puts on the finishing coat. He in turn rolls it upon the same double track into another oven and it follows the same process of drying. When completed it is taken out and gets a coat of blacking while it is still warm.

I might go on and give a great many methods of making cores and core arbors, but the same in core making as in molding one has to be guided by judgment, experience, and circumstances, as to what promises to be the best method to adopt. The number of castings required must also be considered so as to be sure that whatever method is adopted that it will pay. It is here that the specialist gets in his work and produces castings at phenomenally low costs. This can, however, only be done when quantity is one of the main factors.

The question is often asked what size of outlet should be given in venting cores. The best practice is to get it as large as possible, for the larger the outlet the less liability for the passages getting closed. It has been maintained that an opening of one-eighth of an inch area is large enough for a cubic foot of core. I have in some instances had a smaller opening, proportional to the size of the core, for a vent passage, but it is not always good practice to have such small passages. When the outlets are very small it is not good policy to put many cinders into the cores as the more cinders present in a core, the more gas is generated. It is in cases of this description that the designers of castings can materially help to simplify work in the foundry, and if they were more conversant in foundry practice there would be more sympathy and respect for the molder, on account of the many difficulties he has to overcome.

The kind of material most commonly in venting cores is cinders. These are the best and the cheapest, and have a tendency to steady the pressure of the gas when generated, and allow it to pass off very easily. The arbors in the cores also make an excellent vent, for when the core is dried the heat in drying expands the rods and causes a continuous space throughout the whole core. In very sharp points in cores it is good practice to simply put plenty of rods without any vent passages whatever as the rods will be sufficient and are more safe.

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THE EFFECT OF MELTING STEEL WITH IRON IN THE CUPOLA.

BY H. E. DILLER, CHICAGO, ILL.

It is well known that melting steel with iron in a cupola adds strength to the resultant casting. But to what degree this is so, and the best proportion of steel to use are not so clearly understood. With a view of learning something more definite in regard to these two subjects; and also to see if it were possible to trace some connection between the percentage of total carbon in the iron, and the tensile strength, I have made the tests given in the accompanying table.

The tensile and transverse strength given, are the average of two, and in some cases three, test bars. For the tensile strength a 1⅛ inch round bar was used. The transverse strength was obtained from a one inch square bar placed on supports twelve inches apart.

The objects sought in the following classification is to have the silicon about equal in the tests of each set, the amount of the other elements being as nearly alike as it was possible for me to get them.

Tests Nos. 1 and 2 show comparatively little difference in the chemical contents, except in the manganese and graphite. As the manganese in No. 1 should be beneficial to the strength of the bar, the only way to account for the greater strength of the iron from No. 2 is the lower percentage of graphite, or the molecular structure resulting from the 25 per cent. of steel in the mixture.

Comparing Nos. 3 to 7 we find that the strength increases with the percentage of steel used, and the decrease of total carbon with the exception of No. 7. In this 37½ per cent. of steel was used, and the total carbon was less than in any other test, but it is weaker than either No. 5 or No. 6. This being a solitary

case it can hardly be used as proof that 37½ per cent. of steel is more than it is well to melt in a cupola. But test No. 11, which also contained 37½ per cent. of steel and more carbon, was only a little stronger.

Test No. 4 was considerably weaker than No. 5, but its higher percentage of sulphur with its lower combined carbon would seem to indicate that these bars were either cooled slower, or poured from duller iron than were the bars from No. 5, which may account for their being weaker than the No. 5 bars.

In looking at Nos. 8 to 11 we see that No. 9, although containing 12½ per cent. of steel is no stronger than No. 8, in which there was no steel. And No. 10 with 1.06 combined carbon, and 12½ per cent. of steel, gives less strength than might be expected. As these tests are so much lower in manganese than Nos. 8 and 11, it may be that their weakness is due either to the lower manganese or to the conditions of melting, which reduced the percentage of manganese so much more than in Nos. 8 and 11. The four charges each contained about .50 manganese before melting.

Nos. 13 and 14, each from charges containing 25 per cent. of steel, show a marked increase in strength over No. 12.

We find that all the tests from charges containing 25 per cent. of steel are stronger than those from the charges containing but 12½ per cent., with the exception of No. 5, which is stronger than two of the tests which had 25 per cent. of steel in the mixture.

The tests were made with pig iron, ferro-silicon and steel scrap, no cast iron scrap being used. This was done in order to better control the percentage of the elements in the iron.

In some cases when a large percentage of steel was added, it was necessary to use ferro-silicon to get the desired amount of silicon in the charge. To see how this and the steel mixed with the pig iron two tests were taken from No. 13, which contained 1,000 pounds of steel, 400 pounds of ferro-silicon (8.5 per cent. silicon) and 2,600 pounds of pig iron. The charge was tapped from the cupola into a ladle, and the tests taken at different times, as the iron was being poured from the ladle. The one sample contained 2.53 and the other 2.54 per cent. of silicon.

Two tests taken in the same way from No. 14, contained 1.97 and 1.94 per cent. of silicon. This charge was made up of

No.	Silicon	Sul.	Phos.	Mangan.	Comb. C.	Graphite	Total C.	Tensile Strength	Transverse Strength	Per Cent. of Steel
1	1.43	.047	.564	.82	.67	3.14	3.81	23060	2550	0
2	1.50	.065	.532	.33	.64	3.44	3.08	30500	2840	25
3	1.76	.062	.488	.53	.51	3.12	3.63	22180	2440	0
4	1.76	.139	.515	.57	.43	2.94	3.37	27090	2770	12½
5	1.77	.069	.339	.49	.56	2.87	3.43	32500	3120	12½
6	1.83	.100	610	.55	.51	2.44	2.95	36860	3280	25
7	1.75	.089	.598	.35	.74	2.12	2.86	30160	3130	37½
8	1.96	.104	.446	.44	.63	3.18	3.81	21950	2230	0
9	2.12	.037	.410	.26	.38	3.26	3.64	21890	2470	12½
10	2.16	.060	.315	.20	1.06	2 30	3.36	26310	2670	12½
11	1.97	.093	.470	.48	.57	2.83	3.40	32530	3050	37½
12	2.35	.061	.515	.56	.54	3 40	3.94	21990	2200	0
13	2.53	.104	.490	.54	.60	2.56	3.16	33390	2850	25
14	2.36	.064	.327	.24	1.08	2.15	3.23	31560	3200	25

1,500 pounds steel, 450 pounds ferro-silicon, and 2,050 pounds of pig iron.

Similiar tests from charge No. 2, which was made up of 1,000 pounds steel and 3,000 pounds pig iron, contained 1.50 and 1.52 per cent. of silicon.

These three cases offer pretty strong proof that the pig iron, steel, and ferro-silicon mixed thoroughly.

Although of a limited number, the tests given seem to indicate that 25 per cent. of steel will add about 50 per cent. to the strength of the iron; and 12½ per cent. of steel, approximately 25 per cent. The tests containing 37½ per cent. of steel were hardly as much improved in strength as those with 25 per cent. of steel, from which we may infer that the limit of the amount of steel it is beneficial to melt with iron in a cupola, is between 25 and 37½ per cent.

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SOME METHODS OF INCREASING FOUNDRY PRODUCTION.

BY DANIEL REID, BIDDLEFORD, ME.

The success or failure of a foundry manager does not depend on his ability to give a correct chemical analysis of the material he uses, nor his ability to figure for his employer almost unheard of ratios in melting iron with coke, nor yet in his own unquestioned ability as a molder. The combination of the three, however, go a long way in contributing to his success in this "Progressive Age" of ours.

It is a progressive age, as we must all admit, with its developments in the arts and sciences. In our own industry, the molding machine has taken gigantic strides, though still almost in its infancy. From a business standpoint, this is also an age of competition that is keen and sharp at all times, and at periods becomes so bitter as to be criminal in its effects, and necessitates the intervention of the law.

Competition is healthy to any business, when carried on in a fair manner, and it is at the present time when you are in the market for work, that the production is of the most vital importance, for apart from the cost and sometimes taking precedence even over this, the question of delivery will often determine who shall have the contract.

Right here is where a manager makes or mars not only his own future, but possibly that also of the firm, for on his ability to turn out the maximum production at a minimum cost with the men and room at his command, lies the whole secret of success.

During the past year, we have received through our "Journal" splendid articles on various topics that incidentally touch on this matter of increasing production, prominent among which is the article on "Molding Machines" by Mr. S. H. Stupakoff of Pittsburg. The molding machine from the plain and exceedingly cheap but useful press to the latest creation of the automatic,

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"which does everything but pour the molds," is the greatest factor the founder can use to increase his production, whether he is in the specialty or the jobbing line, and in the article referred to above, the writer has handled this subject in such a very able manner, that I simply endorse his statements, and draw your attention to some very good advice he gives at the end of one of his papers.

Sometimes, a foundry, while equipped with all the modern appliances for turning out work, finds itself unable to live up to its contracts, and the following method was employed in one, which, though not modern in all its equipment, yet competes successfully with those that are, in the general light, machinery work. Being part of a large plant for the manufacture of light machinery, there came a time when the other departments were compelled to run night and day, with the natural result that the foundry, already taxed to its limit, was unable to keep up the work for the machine shop. Part of the work was therefore given to another foundry in order to help out. This was most unsatisfactory to every one, except the other foundry, and the manager adopted the same system, with modifications, as the machine shop, namely two crews of molders, machine operators and laborers.

The day crew began work at 5.30 A. M. and worked till 5.30 P. M., with one hour for dinner, receiving twelve hours as compensation, while the night crew started at 5.30 P. M., and did not finish till 12.30 or 1 A. M., getting paid for eight hours. The crews changing about every week, payments being made every two weeks, their average time being ten hours daily. On Saturdays the men started one-half hour earlier, to avoid Sunday work.

Previous to this arrangement, the men had been receiving three hours extra as a premium for additional work, while the two cupolas, one small remodelled McKensie and a large one of the same type, were supposed to be at their limit, giving in two heats twenty-seven tons of a melt daily.

In the writer's opinion, the doubling of this amount of iron melted, which was accomplished and even exceeded at times, is the most creditable part of this method of increasing the production. The small cupola was used in the forenoon, being

timed to drop bottom at 11.45, and bringing down a melt of twelve tons. Five hours later a laborer "chipped" it out getting it ready for the melter and his assistant, who after eating their supper had this cupola ready for the blast at 9.30 P. M., when a second heat of seventeen tons or over was melted in the one cupola, making a total of twenty-nine to thirty tons every twenty-four hours from a cupola rated by the builders at four tons per hour.

The main heat of the day was in the large cupola, which seldom went under twenty-seven tons, this being arranged to get through at 5.30 P. M., there being one section of the shop that worked 10 hours straight.

This system of increasing the production was carried on most successfully for a period of seven months, until business became normal again, and at the end of that time the foundry was nearly three months ahead of the machine shop, which is an exceedingly good thing to have during the time for labor agitations of various kinds.

As stated before, the cupolas used were of the McKensie type and the height from bottom plate to bottom of charging door was only 9 ft. The daily consumption of fire brick used in patching was only eight on an average for the entire period of seven months, when the small cupola was relined to the charging door.

How about the molding sand you would ask, and my reply is that this was taken care of by pouring the front of every floor that was to be used at night, in the first or morning heat, and having laborers take out the castings and wet the sand. When the balance of the work was poured and dumped, that sand was placed one side leaving the cold sand ready to be used by the night crew.

In regard to the cost per pound of producing castings by this method, though not at liberty to give exact figures, I can assure you, that it was less than the six months preceding, when the men were receiving premiums.

Mr. R. C. Cunningham in his paper on "Foundry Costs" brings up a point that gives a glimpse at the possibilities for increasing production by the division of labor where it belongs. The steel works and some of the specialty foundries have to a

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great extent solved this problem, and in the recent conference of the Iron Molders Union and the Stove Founders National Defence Ass'n, it was recognized by the molders that the general trend of industrial development is in employing skilled labor, as far as practicable, at skilled work. I am willing to predict that in the future, and how near for you individually, depends upon your managers to a great extent, that every molder without reference to the class or character of the work, will do nothing but produce, leaving the pouring, the dumping up of work, the cutting and mixing of the sand and all other laboring work, to unskilled labor.

When you reach the point where the molder starts in the morning to practice the art at which he has served a number of years' apprenticeship, and continues at that work all the time he is being paid for, then and not till then, will you have solved the problem of the greatest production at the lowest cost.

A number, how large I do not know, of you here to-day, run jobbing and general machinery foundries, and I venture to say that certainly 95 per cent. of your molders stop when the blast goes on, whether it gives them six or seven hours of molding time, and as all cannot pour first, the greater part of your crew are waiting their turn and doing nothing.

What matters it if you insist on their staying in the foundry till the whistle blows, do you gain anything by it, except the moral effect it has on the other departments, which of course is no small matter?

You might ask how the molder would take to this system, and though they appreciate the efforts in this line, in the Stove Foundries where it is all piece-work, yet in machinery work, might it not cause trouble? Having a large number of molders working under this division of labor principle, I can say that they are perfectly satisfied and think it the finest scheme yet devised, as they have no pouring or dumping to do, thus eliminating the hardest and hottest part of what formerly constituted their work.

The only objection, that comes from any one, is in regard to the pouring crew. But obstacles are encountered only to be overcome by the ambitious, and the men who do the pouring may be only laborers under the direction of a molder, trained for

that special work as you would train them for the molding machine. Or if you prefer it, they can be culled from your apprentices with the addition of a molder or two as leading hands, while a large majority of your molders keep the cost where it belongs by producing molds.

The dumping and cutting over the sand in the machinery shop where this system is in vogue, is accomplished by means of a night crew of laborers, fifteen in number, who take care of the work of one hundred and twenty men, in twelve hours.

That the pouring requires a certain amount of skill, is granted, for on that often depends the quality of the work, yet we have an instance right here in old New England, where laborers, trained of course, pour up the entire amount of work put up by the molders in a foundry handling nearly twenty-five hundred (2500) different patterns in a week, the weight in the casting varying from an ounce to 275 lbs.

The immediate result of this method of increasing the production was the saving of one day's wage all around, as the same amount and over in fact, was produced in five days, where before with the same crew it took six.

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BRASS MELTING.

BY CHAS. VICKERS, CHICAGO, ILL.

Compared with steel or iron, it is an easy matter to melt brass. On a small scale, it is frequently melted in an ordinary heating stove, or on a forge, (in the latter case, however, a temporary furnace must be formed of brick, and the crucible coked up therein). Such crude methods though, are suited only to the amateur, or where a small breakdown job is needed in a hurry by some firm not having the ordinary melting facilities.

When brass is melted on a large scale, the furnaces are a very important part of the plant, and it pays to do considerable thinking and figuring before building them. The character of the castings to be made, must always influence the size of the furnace, as small furnaces are much more economical for the production of small and light castings than large ones. This is a thing not always considered however, so that it is a common sight to see a "30" pot put into a furnace intended for a "hundred." The coal dealer may never kick at this, but his debtors often do at the size and frequency of his bills.

Here then is one point in brass melting, whatever the size of the furnaces, three inches of solid fuel around a crucible will do as much work as six, and is more economical in fuel, labor and metal.

The fuel saving is apparent without a thought. The labor saving requires a little more effort to perceive. We must consider the extra shovelling and "poking down" required by the larger furnaces, while as to metal saving, some people may not see that point at all unless it is explained. Therefore, the larger the fuel surface, the greater the heat, thrown towards the furnaceman when he removes the cover, and the greater the temp-

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tation to stand away off, and "peg" the metal at the crucible when the foreman isn't looking.

Some melters become quite expert at hitting the crucible, and most of the metal charged, finds its way therein. But they can never overcome the splashing when a chunk drops into the liquid contents of the pot, and most of these splashes are lost in the fuel, and they are metal. So this is bad practice, and generally costs more than the loss of fuel. Another little point to be considered in economical melting, is never to charge up a pot, unless one is reasonably sure that the molds are going to be ready when the metal is, because it costs money to "hold" a pot in the furnace, as is frequently done. Then again the much abused crucible will wear away as much or even more, when only half filled than when filled.

And still again, never build or allow your furnace to become "barrel shaped," high-faluting theories to the contrary notwithstanding. A straight wall is always the best.

As far as we have gone with these remarks, no particular style of furnace has been recommended as being better than others, because most brass-founders have their own theories in this respect, and although they may differ in minor details, most solid fuel furnaces bear a general resemblance to each other, so much so that there is another defect so serious and so universal, that lots of good strong language might with advantage be used thereon.

Not that there is any intention of using strong language here, we will leave that in the shop mixed with the gas that causes it, and in a few mild words explain the trouble, and suggest a remedy. As before mentioned, this trouble is caused by gas, the products of combustion being too often driven into the shop, polluting the atmosphere to such an extent, that the health of the human beings employed therein is seriously endangered. For molders are human beings, although some people seem to doubt it and think that anything will do for people employed at such dusty, dirty work.

Many founders imagine that when power is applied to furnaces it is impossible to carry off all the gases, and so it is, with flues adequate for natural draught, but when the air supply to a furnace is increased by the application of a fan beneath the fire

the flue area must also be increased, unless the same was abnormally large before the fan was applied.

So if there is gas in your shop your flues are too small, the remedy is to enlarge them, do not go to the trouble of cutting holes in the roof or to the expense of placing ventilating fans, which you will find are failures so far as removing the gases is concerned. And right here, let me impress the fact that it is not always the main flue which is faulty, most founders make this generous in size, turn your attention to the flues connecting each furnace to the main flue. Your foreman may pooh-pooh the idea and advance all kinds of theories to the contrary, but do not listen to him, he needs educating on this point and see that he gets it, or get a new foreman.

There is no evading the fact, that if a flame is driven from beneath the covers of furnaces, the products of combustion are being driven into the workshop instead of through their proper channels into the outer air where they are harmless. In place of driving air through a furnace, in some few cases the fan has been placed in the flue and by exhausting the air therefrom creates a strong draught through the flues, the furnace being operated the same as natural draught, that is with open ash pits.

With this system a high chimney is not necessary, and the atmosphere of the shop is entirely free from contamination by the products of combustion. It possesses one disadvantage to careless people, and that is the flues and their connections must be kept in good condition, should they be permitted to fall into decay, the melting capacity of the furnaces would diminish in proportion to the air leakage.

For this reason, unless exceedingly well built, brick flues are not so well suited to this system as are iron ones, because the average brick flue, built by the average brass melter or his foreman, is never built as well as the poorest bricklayer would do it, and consequently rapidly crumbles under the racking effects of expansion and contraction.

When sheet iron is used for brass-furnace flues, they are best when made circular in form, with rectangular cast iron connections to each furnace, the main sheet iron flue must be suspended and not allowed to touch a wall or any non-conductor, if the air has free access to it the flue will rarely become red hot,

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and will consequently give good and economical service.

If the heat radiated from the flue troubles the melter, which it probably will, do not sheathe it in asbestos, or you will soon have nothing but an asbestos paper flue and a poor one at that, but hang a curtain of asbestos in such a manner as not to touch the flue, but still shield the melter.

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VOL. XI. JUNE, 1902. PART I.

ECONOMY.

BY P. R. RAMP, SCHENECTADY, N. Y.

Economy is something that is essential in carrying on a business of any kind. The foundry business is no exception to the rule, and at no time is there an opportunity for so much thought and study along this line in our industry than now.

In our efforts to cut expenses we sometimes begin at the wrong end, and as the old saying is "We spend a dollar to save a cent." During my experience as a foundry man, I have heard many men express their views as to cheapest methods of production.

While I have often been able to profit by suggestions, I have listened to some arguments which were amusing. In order to produce good work, work that must come up to given specifications, we must use good material. I have a personal dread of cheap blacking, cheap foundry flour, poor molding sand, soft coke, poor iron, etc.

A poor grade of material can be purchased for nearly one half the cost of a better and more suitable article. Yet it is generally economy in the end to purchase the best, as the reduction in loss of bad castings will in many cases exceed what is gained by the reduced price of the cheaper material. The following are some of the materials that are often brought to our notice as something that can be bought cheaper and will save us money. For instance a foundry flour at one half what the regular supply is costing us, yet when a carload is received we find it is necessary to use about twice as much as we take of the old flour to do the same amount of work. This is detrimental in more ways than one.

In making cores or dry-sand molds, the more flour is used in the sand mixture, the more gas there is generated. And the more vegetable matter that will produce an excessive gas, the

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greater possibilities there are for a cut, scab, or a blow, which results in a bad, or dirty casting.

The greater the amount of flour we are forced to use in order to make strong cores or molds, the more they will swell while drying. This causes them to vary in shape and size.

Another item is "plumbago," "blacking" or "dry sand facing." We may be paying 4 or 4½c per pound for a lead that is doing good work and pealing the castings in a very satisfactory manner, when along comes a "supply man" and induces the purchasing agent to buy a car-load of a cheaper lead, say for 2½c per pound. This lead he will probably say, is used by several large concerns, whose product we know is all that could be desired. Here is where impractical man is lead astray. He does not consider what quality of sand the parties referred to are using behind this lead, perhaps this is a good open sand that would do the work nearly as well without any lead or facing. We try this lead on our work, our sand is close and contains matter which promotes the formation of gas, and this creates in the molted metal an uneasy motion while it is being poured and after the mold is filled before it solidifies. This action of the iron causes additional wear on the surface of the mold and the cheaper grade of blacking will wash and rise to the surface, thus producing a dirty casting.

Poor molding sand is a great draw-back. I have in mind a firm that obtains a very poor grade molding sand from a supply house some 200 miles away, when better sand could be dug within one mile of the shop. The only objection is, this good sand cannot be shipped in carload lots, but must be hauled by wagon loads, which is really preferable as it is an easy matter to reject the wagon load of poor sand and receive a better grade from the same wagon an hour later. But 'tis no small job to be compelled to work up three or four carloads of inferior material.

Poor coke causes much trouble. I know of a large concern in the west who use a very cheap grade of soft coke for melting purposes because it can be purchased at about $3.00 per ton less than good seventy-two hour coke would cost. They claim a saving in this method, but it is my belief that if they should consider the extra time consumed in melting and the castings that find their way to the scrap pile on account of dull iron, they would

realize that there is more economy in using a good grade of coke.

The same is true where one blower is used to furnish wind for two cupolas, and the capacity of the blower is but a little more than is required for one cupola. This makes it necessary to put the blast on at say 12.40 or 1 o'clock, and with two cupolas one 60 inches and one 48 inches diameter, it is a good job to melt 60 tons by 5 o'clock, which means 15 tons per hour for two cupolas. Now, if an independent blower were used for each cupola, with the proper tuyers location, the time consumed in melting could be cut nearly in half. This would make it possible for the molder to work up till 3 o'clock P. M. at molding. instead of beginning to pour off at 1 o'clock, which would mean two hours more. This would in a short time pay for several new blowers.

When we refuse to give our molders good flasks and good patterns to work with in order to save, we often loose more in bad work than it would take to build new patterns and flasks. to say nothing of the delays caused by failures of molders to make good work which may be directly traced to poor rigging.

To those who have always considered the building of flasks, an unnecessary expense, and have practiced the most rigid economy in regards to them, I want to say that good molders are hard to get and expensive. In shops where the proper appliances cannot be secured, they are hard to keep. But if we make the equipment of the foundry a personal study, and build our flasks, patterns, etc., in a manner that will simplify the work regardless of first cost, the question of good molders will be settled. With all conditions as they should be and the work and methods made easy it is possible to develop good molders out of what men we have in our own shop or even out of men that have never handled a rammer or shovel. I would prefer the latter as I believe there is much more economy in teaching a green man how to mold and paying him for scrap castings for a couple of weeks, and later receiving a fair day's work from his floor the year around, than there is in compelling a molder who has worked at the trade all his life to work in a different manner than he has been accustomed to.

The idea of economy with reference to pattern making is

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in some cases a delusion. For instance it is more expensive to give a large gang of men one locomotive cylinder pattern and have them ram and finish two or more a day, than it would be to make two or more patterns and let them make one a day each. Two molders will accomplish more in a day than one half of what four men will accomplish on the same job with only one pattern. Besides this, much better work is the result of placing fewer men on the job. Hence where we have a number of castings to make in a rush, it is cheaper to build an extra pattern than to crowd too many men on one pattern.

In making iron flasks for locomotive cylinders it is economy to make separate flasks for the different sizes, where there is any great variation. It is false economy to try to use one large flask for all sizes. The reason is plain enough. On the small ones the same amount of labor is required to ram it up as on a large one when one large flask is used. And in drying the mold double the amount of fuel and time is required, to say nothing of the danger of the large body of sand saging and causing the mold to loose its proper shape.

There are many other things that could be mentioned which cause much waste, such as insufficient dry sand and core oven capacity, crooked core plates, improperly constructed patterns, system of handling melted iron, casting, sand, flasks, etc.

The different items I have made mention of in the above are not new to foundrymen. Although we all realize that these things help to increase the costs of production, there are many foundries to-day where just such conditions prevail.

Journal of the American Foundrymen's Association.

VOL. XI. JUNE, 1902. PART I.

FOUNDRY COSTS.

BY R. C. CUNNINGHAM, HOLYOKE, MASS.

At the annual meeting of the American Foundrymen's Ass'n held in Buffalo a year ago, I presented a paper on "Foundry Costs." The ground I took at that time was that we were doing a large amount of work in our foundries which only increased our costs and did not increase our production, this unnecessary work being due to badly made and worn out patterns. The article was severely criticized by pattern-makers and others in trade journals and by personal letters. One man went so far as to say that the principal reason that foundrymen were not consulted more in the construction of patterns, was that very few could tell by looking at a drawing how a pattern should be made, and during his twenty-five years experience as a pattern-maker he had only met one foundryman who could read drawings intelligently. It was claimed that the paper had a tendency to create a bad feeling between foundrymen and pattern-makers and there would be constant wrangling as to how patterns should be made. I certainly had no intention of saying anything to belittle the pattern-maker or to provoke discord in any shop. I made the statement at the time only in the interest of the foundrymen, and I feel to-day that I am backed by a large majority in what I said.

Shortly after the convention I had an occasion to visit a prominent concern. In conversation with the manager he told me that he thought my paper would do good, and wanted me to go through his works and tell him just where he could save money. He further added, "I think we are about up-to-date, but am willing to learn." I went into his foundry and in observing things my attention was attracted by a molder standing ap-

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parently waiting for something. While I was watching him the workman next to him passed him over his rammer. He took it and went to work. Upon investigating I found that these two molders had only one rammer, one shovel and one No. 4 riddle. Neither had a fine riddle, brush, pail or bellows, nor in fact any of the tools that are usually furnished by the company. They had quite a number of helpers in the shop. They did not give each of them a shovel. I spent the greater part of a day about the shop carefully observing the way the place was managed and I think I am safe in saying that 10 per cent. of the men did not have proper tools to work with and depended on borrowing from the other men or upon what they could pick up about the shop.

As I was leaving the manager called me into his office and inquired if I saw anything I would have different. I told him I thought there was some things that could be improved upon. He wanted to know what they were. I told him of the things I saw in the shop. He thanked me and said "I will look into it and I will write you." This happened about 10 months ago. I had forgotten about it when a few weeks ago the following came to me:

"You will remember spending a day at our works several months ago and of expressing yourself upon how you found things in the foundry.

"The next day after you was here I went into the foundry to find out the truth of your statement and I will have to admit you did not half tell it. I went into the foundry and stayed there over a week and I will say candidly I do not see how the men could do as much work as they did. In a few days every man had his supply of tools marked with his number. I stopped the molders waiting around in the morning. I had all their patterns and flasks on their floors by seven o'clock. I have the flasks fitted before the job comes into the foundry. The molders work no harder than they did before, but we are turning out more castings and they are much better. Our expenses remain about the same, lower if anything, which shows a reduction in the costs.

"The statements you made in your paper before the American Foundrymen's Association last year were facts. Our foun-

dries are neglected. We should pay the same attention to them that we do to our machine shops.

I sincerely hope you will give us another paper on the same subject this year."

This letter comes from a man who thought his foundry was up-to-date, and I have no doubt that there are many more of the same mind. Now I wish that every foundryman present at this convention, when he returns to his own home would go into the foundry and do as this man did, stay there a week or a month if necessary (it is a good healthy place to stay) and just take notice of the patterns that come into the shop and see if the molders have the proper rigging.

See that there is no waiting for anything. Give your molders a chance and you will be surprised at the results. Now I wish every foundryman present to-day would try this and at the end of three months write me the results, no matter what they are I would like to know how you found things in your shops. Those of you who are about your shops daily have no doubt seen and corrected every thing of this kind found there, but those of you who walk through your foundry only occasionally are the ones that I want to take this to heart and bear in mind that the little annoyances are where the time is lost. They may seem small in detail but are large enough in the aggregate to increase the cost of your castings. The time when we can get more than a fair day's work from a man has gone by and to-day every foundryman must keep close watch on his costs and production or he will find the balance on the wrong side of his ledger. In my opinion his only hope is to devise ways to do his work with more unskilled labor. By doing this he will not be dictated to, but will have a chance to get more benefit of his brain work than is now accorded to the employer of skilled labor.

There is one fact that we must not close our eyes to, and that is that the tendency of organized labor is to keep the production down to the lowest possible point, and at the same time increase the minimum rate of wages. Now with these cold facts staring us in the face we must watch very carefully and see that no work is done that we get no returns for. An hour or two spent on a badly made or worn out pattern means an increase in our cost, and does not increase our production, and

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in order to overcome this we must figure and scheme to have things so that the moulder can turn out more work. It is an increase in our production without any increase in our cost, is what we must aim for. To do this we must study every pattern, and if we can, by making changes, make a mould any quicker, we should not delay a single day in doing so.

I want to give you one illustration on this point. We have at our works a pattern for a 16" steam piston ring. During the past twenty-five years the company has made thousands of these rings. They were moulded in the usual way. The pattern was made about one inch wider than the casting wanted, to be able to secure it on the face plate while turning. The ring is then cut off the desired width, and cut into four segments. The actual cost of labor on one set of these castings when they were ready to put into the cylinder, was seventy-five cents. The casting in the rough weighed twenty-three pounds. The finished casting weighed seven and one-half pounds. The waste piece cut from the ring, that went into the scrap, weighed six pounds. Nine pounds went into turnings. I expended three dollars and seventy-five cents on a new pattern and plates, and am now putting these same castings into the erecting room for four cents a set, besides the saving on the iron. I am saving seventy-one cents on labor on each set of castings. The company makes probably five hundred set of these rings a year, including the new work and repairs. The saving on this job alone amounts to three hundred and fifty odd dollars. A half dozen jobs like this would pay the salary for a good man for one year.

I do not claim that every job can be put on a machine on plates and the same results obtained, but even if we can get an increase in our production of 25 per cent. without any increase in our expenses, it is certainly worth trying for. Our company has put on during the past year over two hundred different patterns on plates, and on none of them have we made anything less than 50 per cent. saving. Any foundryman is welcome to come and inspect our patterns. We have no secrets about our shop. What we have learned by experience we are willing you should profit by if you wish.

An amusing incident happened at our works a short time ago. A foundryman was visiting our shop and I was showing

him this same pattern which I have mentioned here. After looking it over carefully he said: "It is a very fine idea, but I fail to see where you get any credit for it. According to your own statement you have cut down your production about two-thirds, now, unless your firm does different from any other you only get credit for what castings you turn out, where you formerly got credit for 23 pounds of castings, now you only get credit for $7\frac{1}{2}$ pounds. It looks to me as if you were helping the machine shop at the expense of the foundry." I told him I was working for a firm that gave credit where it was due, and I think that every company should let their men understand that any improvements gotten up to reduce the costs or increase the production would be liberally paid for. It should be the aim of every foreman to encourage this among his men, particularly among the younger class. There is nothing that encourages a young man as much as it does to ask his opinion. We must remember that from among the young men we are to find our future foundry managers, and when they take the burden from our shoulders let us have the satisfaction of feeling that we exercised our ability to its fullest extent in filling up those dangerous pitfalls and removing as far as possible the stumbling blocks from their paths.

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THE METALLURGY OF THE CUPOLA.

BY H. E. FIELD, ANSONIA, CONN.

Boston brings to our minds thoughts of art, education and culture. We have shaken the foundry dust from our clothes and have come down here with a feeling of relief at having for a day or two escaped the worries and vexations which are inseparable from the foundry business. It is, therefore, with considerable temerity that I undertake to carry you back in thought to that part of the foundry which is the centre of most of our troubles, viz., the cupola.

I have no ideal cupola to bring before you, no improved wrinkle of center blast, steam melting, or ozone generator. I shall devote all the time you have so kindly placed at my disposal to a study of the effects of melting upon iron, and upon the metalloids therein contained. Numerous contradictory statements concerning this subject which have appeared in recent books and journals, together with several requests for information in regard thereto, have led me to choose this somewhat technical topic for my paper.

The quality of cast iron depends, to a great extent, upon cupola practice. The best of pig iron can be changed into inferior cast iron by poor melting; while an inferior pig may, by judicious melting and mixing, be used in high grade castings. There are hardly two cupolas in existence which work under exactly the same conditions; with the same sized tuyers; the same amount of blast; with equal height of tuyers from cupola bottoms, etc. For every variation in cupola arrangement, there is a variation of the effect in melting iron. The greater the difference in the cupolas, the greater will be the variation in the melted product. Pig iron and coke merchants frequently find

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that two firms engaged in exactly the same line of work and using the same iron and coke, get very different results. Let us take as an example an experience which the managers of a certain foundry had with coke. They had used for a number of years a standard brand of Connellsville coke, and their cupola had been so arranged as to give the best results with this coke. The agents for another grade of coke, of a much lighter nature, finally persuaded them to try a car of their coke. After carefully ascertaining that a neighboring foundry was having excellent success with the lighter coke, they bought a carload. The first day it was used the trouble began and continued to such an extent that no more of that coke would be taken as a gift, and the last of the car was worked up, mixed with one-half Lehigh broken coal. Upon inquiry, the cause of the differing results obtained by them and by the neighboring foundry, which was using the same light weight coke with such excellent results, was found to be this: In their own cupola the distance from the tuyers to the sand bottom was but eleven inches, while in the cupola in which the lighter coke was being used so successfully, the distance was twenty inches. The tuyer area in the former was but one-half that of the latter, while the pressure in the former was greater by four ounces. This needs no explanation to one familiar with cupola practice.

Turning from coke to iron we find that the percentage of loss or gain of the metalloids or impurities varies with the height of tuyers, size of bed, melting ratio, the size of the tuyers, pressure of blast, amount of flux, and the method of fluxing. When pig iron, in the course of melting, comes in contact with the blast, and is acted upon by it, certain of the metalloids are burned out of the iron. This is true in all cupolas. The amount burned out increases with the amount of air forced into the cupola by the blower. In the same cupola, and under the same conditions, irons varying in composition will lose different amounts of impurities. As the melted iron, freed to a certain extent from some of the metalloids, passes through the incandescent bed of coke or coal, it absorbs new impurities from the bed. The amount absorbed varies with the cupola practice. From a heavy or deep bed, other conditions being equal, more impurities will be absorbed than from a light or shallow bed.

The temperature of the iron at this time has a decided effect upon the amount of metalloids thus taken up by the iron, as does also the amount of flux used. With a hot running cupola and a large amount of flux, little sulphur will be absorbed by the iron, while a large amount will come off with the slag.

There has been much discussion in the last year or two as to whether certain of the metalloids lose or gain in passing through a cupola. The great variation in the results obtained by reliable experimenters has led to a general belief that there is no fixed rule which can be followed in figuring these cupola losses and gains. This idea, however, is incorrect, as I shall try to prove by taking up each metalloid separately.

SULPHUR.

Under ordinary condition, iron melting in a cupola takes up sulphur from the fuel. The greater the percentage of fuel, and the greater the percentage of sulphur in the fuel, the greater will be the amount of sulphur absorbed by the molten iron. The ratio between the total amount of sulphur present in the fuel and the amount absorbed by the iron is dependent upon three conditions, first, the kind and quality of flux used; second, the temperature of the iron; and third, the composition of the coke and iron. A proper quantity of flux in a hot working cupola will take care of a considerable amount of sulphur. The sulphur present in the fuel as a sulphuretted hydro-carbon has no appreciable effect in increasing the percentage of sulphur in the melted iron. This accounts for the fact that many foundries melting with coal obtain castings with a lower percentage of sulphur in proportion to the amount of sulphur in the fuel than do foundries melting with coke. The greater the amount of manganese in the iron, the less sulphur will the iron absorb; and it is possible in cases of very high manganese iron for that iron to lose sulphur in melting; the sulphur passing off as manganese sulphide with the slag.

SILICON.

In passing through a cupola iron always loses in silicon. The amount of the loss depends upon two conditions; first,

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upon the amount of oxygen brought in contact with the metal in melting, and second, upon the composition of the iron as it goes into the cupola. In giving the amount of silicon lost in passing through a cupola, authorities generally mention a fixed amount. This may have been true concerning the grade of iron with which the writers were familiar. But it would be wholly untrue concerning other grades. The greater the amount of blast, the more silicon will be burned out. The higher the percentage of silicon, the greater will be the percentage of loss in passing through a cupola. (By percentage of loss, I mean the ratio of lost silicon to the original amount of silicon in the pig). An iron running four per cent. in silicon, will lose up to twenty per cent. of its original amount, while the loss in an iron running .2 of one per cent. is hardly perceptible. This variation in the loss of silicon is accounted for by the fact that the lower the percentage of silicon in the iron, the greater is the affinity of the iron for that silicon, and the more difficult will it be to oxidize it; while on the other hand, the greater the amount of silicon present in the iron, the less will be the affinity and the greater the amount oxidized in melting. The percentage of carbon in the iron has a great deal to do with the loss of silicon in melting. This, however, will be taken up later under the consideration of carbon.

PHOSPHORUS.

A very slight amount of phosphorus is absorbed from fuel by iron in melting. It is practically, however, a constant quantity, the small increase being proportional to the amount of phosphorus in the fuel.

MANGANESE.

Manganese loses in passing through a cupola. Its action is that of a protector from oxidation and the amount lost in passing through a cupola depends upon the amount of blast and also upon the percentage of sulphur in the fuel. The greater the amount of air forced into the molten metal the more

manganese there is lost as an oxide. The greater the percentage of sulphur in the fuel, the greater will be the percentage of manganese passing into the slag as a sulphide. Manganese is not united with iron, as a compound, it is rather alloyed with it, having practically no affinity for the iron.

CARBON.

I have left this element until the last for several reasons. Principally, however, because its action is understood less than that of the other elements which we have to consider in connection with melting iron. Carbon is really the life of cast iron. Various articles and papers have been written and much discussion has ensued in regard to the effect of melting upon the carbon in iron. Some say that it gains, others that it loses. If the founder is to be able to control his mixtures by chemical analysis, he must settle this question for himself. The articles written upon this subject are wholly misleading. In the early part of 1900, there appeared an article in the "Machinery," written by Mr. J. E. Johnson, stating that iron lost carbon in remelting. This brought a reply from Mr. Thos. J. West in the following number, in which he contended that iron gained carbon in melting. Mr. West presented a record of the remelting of the same iron five times. In every case the iron gained in carbon. In a recent number of the "Foundry," Mr. W. J. Keep, in answer to a question stated as a positive fact that iron lost carbon in passing through a cupola. These opposing statements from authorities on mixing iron, can but discourage anyone who is attempting to learn from the writings of others the changes which iron undergoes in melting. A few weeks ago the following was referred to me by a foundry foreman. In order to determine the loss and gain in impurities in melting in his cupola he melted a quantity of No. 2 iron. He had the pig and the resultant casting analyzed and figured the differences. He then remelted some of the scrap from this heat alone. He had this iron analyzed and figured the change in carbon, etc. These two results were sufficiently conformative to allow him to figure that his cupola lost ten per cent. of the carbon in remelting. Sometime afterwards, having occasion to make castings which

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required a very hard grade of iron, he had these casting analyzed and found that instead of losing ten per cent. of the carbon, his iron had gained in carbon in passing through the same cupola. It was a case of Mr. West and Mr. Keep illustrated in the same foundry. In the experiment of Mr. West, spoken of above, an iron running below one per cent. in silicon was used, and this iron gained in carbon. In Mr. Keep's stove plate work, iron running high in silicon is invariably used, and such iron will always lose carbon in melting.

Iron may both gain and lose in carbon in passing through a cupola, and whether the gain or loss predominates depends, first, upon the original composition of the iron, and second, upon the conditions or method of melting. An iron while passing down the cupola has a portion of its carbon burned off, the quantity depending upon the amount of blast and the time which the iron consumes in passing through that zone of the cupola, where the oxidizing influences are at work. After having a portion of its carbon removed, the molten iron comes in contact with the incandescent coke in the bed, and from this it absorbs carbon. The hotter the iron, the larger the amount of fuel, and the longer the iron remains in contact with this fuel, the more carbon will it absorb. If the amount of fuel is sufficient, the iron may absorb more carbon than it loses in passing the tuyers, and thus the iron will have gained in carbon. If, however, the blast is heavy and the ratio of fuel to iron small, the iron will lose more carbon in passing through the oxidizing zone than it can possibly pick up from bed, and thus the iron loses in carbon. These two conditions are at work every day in our cupolas. Melting with low blast and high percentage of coke will cause a gain, in carbon, while the high blast and low percentage of coke will cause a loss of carbon.

The original composition of the pig iron will have much to do with the loss or gain in carbon. An iron made at the blast furnace with a large percentage of fuel will be high in carbon. This if melted in a cupola with a small amount of fuel, will lose in carbon. While a pig iron low in carbon, made by a blast furnace using a small allowance of fuel, will, when remelted in a cupola with a relatively large amount of cake, gain in carbon. A low carbon iron, then, will tend to gain in carbon, while

a high carbon iron will tend to lose in carbon in melting in a cupola.

There is one more factor which we must consider in discussing this loss or gain of carbon in cupola practice, and that is the effect or rather the relation of silicon to carbon in this process. I have said that low carbon iron gained in carbon. Let us now qualify this statement by saying that a low carbon, low silicon iron, will gain in carbon. Carbon and silicon, although they are analogous elements in many of their properties, have always been considered to be almost opposite in their action on cast iron. The facts of the case are, that their actions are almost identical, although the results are different. Pure iron we know will absorb carbon up to 6.67 per cent., while it will absorb silicon up to 23 per cent. One part of carbon then is about $3\frac{1}{2}$ times as effective on cast iron as is one part of silicon. We find this ratio to exist in our pig and cast iron to a marked degree. For every rise of 0.1 per cent. in carbon in our pig iron made under the same conditions, there will be a corresponding decrease of 0.35 per cent. in silicon, and vise versa. This applies in the same manner to our cupolas. When we melt a pig of say 3 per cent. total carbon and 1 per cent. silicon, we would expect under ordinary conditions, a gain in carbon. If, however, we melt a pig of 3 per cent. carbon and 4 per cent. silicon, we are sure, under the same conditions, to find a loss in carbon. Iron in the melted state may be thought of as a solution in which carbon and silicon each reduces the power of the iron to dissolve the other.

We have found then, that a small percentage of fuel, high blast, high carbon, and high silicon tend to cause iron to lose in carbon, while low blast, large percentage of fuel, low carbon and low silicon tend to cause iron to gain in carbon in melting.

When we consider the great variety of iron in use in foundry practice, and the divergency in cupolas, we can readily understand that no hard and fast rule can be laid down for all cases. Every foundryman must find out for himself, in his own cupola, and with the brands of iron which he uses, or else he must obtain his knowledge from someone whose experience is similar to his own.

Are our cupolas so arranged as to produce at the least cost,

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the best iron for our work? Are we, in order to save a few cents, running them with the least fuel possible, and paying out at the same time, dollars to obtain the superior grades of iron necessary when iron is melted with little fuel? Are we melting with heavy percentages of fuel, and then adding limestone to reduce sulphur, and steel to reduce carbon? Are we using high silicon to soften, when it is really high carbon that is needed, or high carbon when it may be that high silicon would answer the purpose very much better?

For various kinds of work, different grades of iron are required; stove plate and the like demand fluidity and softness, and to secure these an iron high in silicon, high in phosphorus, and rather low in carbon and manganese is most used. For light machinery, an iron high in silicon, medium in carbon and phosphorus and low in sulphur and manganese is necessary. Medium machinery requires an iron medium in silicon and carbon, low in phosphorus and manganese. In heavy machinery where weight rather than strength is desired, and where castings must be free from shrinks and segregations, iron low in silicon and phosphorus, high in carbon and manganese is essential, and a somewhat higher percentage of sulphur may be permitted. In castings where a high strength is desired, an iron low in silicon, low in carbon, low in phosphorus, low in sulphur, and medium in manganese is necessary. Cupolas then, should be so constructed as to best melt an iron suited for grades of its particular foundry.

The height of the tuyers must regulate the manner in which the iron is taken from the cupola. Low tuyers necessitate that the iron be drawn from the cupola as fast as it is melted, and either be held in a reservoir or taken away in small ladles. High tuyers allow the iron to be collected in the hearth of the cupola and to be drawn off in large taps, and have the advantage of allowing crane ladles to be shifted while the iron is collecting in the cupola. When low tuyers are used for filling crane ladles, if any time is apt to be lost in changing the ladles, two spouts should be used, one ladle being placed in position while the other is filling. We have mentioned that for stove plate and like grades of work, a high silicon, low carbon, low sulphur and low manganest iron is best suited. We have also mentioned that the

amount of carbon and sulphur which an iron will absorb is dependent upon the amount of fuel which it passes through. Hence for stove plate, and like work, the lower the tuyers, provided they are consistent with good melting, the better suited will the iron be for the work. This does not interfere with the general practice in stove plate shops of removing the iron in hand ladles and by trolley tracks as fast as it is melted. Light and medium machinery castings require only a medium carbon percentage, and are much more advantageously melted in low tuyer cupolas. The somewhat lower silicon used in this line of work furnishes a higher carbon than is present in stove plate iron, and the small bed gives a low sulphur percentage. In the heavy machinery where softness and soundness are required, a large bed has an advantage. Low silicon irons which are cheaper may be used, and the carbon absorbed from the deep bed makes an iron high in carbon, while the resulting high percentage of sulphur is less detrimental in this heavy grade of work. The deep hearth allows the collection of a large amount of iron and thus makes the custom of tapping into crane ladles practicable. In the so-called strong irons, named by some gun iron, by others semi-steel, we have a somewhat more complicated problem. These irons must, first of all, be low in carbon and low in sulphur, and it is just such irons as these that absorb most readily carbon and sulphur from the fuel. There are cupolas in operation in many of our foundries from which it is practically impossible to obtain an iron above 28,000 pounds tensile strength for the reason that the height of the tuyers requires so great a depth of fuel in the bed, that the iron will absorb an amount of carbon and sulphur so great that it is impossible to get a strong casting. For the melting of this grade of iron, low tuyers are essential, and, of course, the iron must be removed from the cupola as fast as it is melted. The majority of cupolas in operation to-day have extremely high tuyers, and we have seen that these are advantageous for but a single grade of work. In advocating the lower tuyers for cupolas I have always met with the above mentioned objection in regard to changing the ladles in time to prevent the iron getting into the tuyers. It is to obviate this difficulty that I suggest the double spout on cupolas which are so arranged as to make this possible. The modern tendency in building cupo-

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las is to make the tuyers as low as possible in order to show a high fuel ratio, and I venture to predict that they will be built much lower as soon as the double spout arrangement is more universally adopted.

The time has come when all foundrymen must unite in improving cast iron. There has been a tendency for each foundryman to keep to himself the results of his own investigation. This is no more than natural, but it has proved a short sighted policy. The fact that you can make a good quality of castings, is no excuse for allowing another founder, through his ignorance, to deprive the cast iron market of certain classes of work which an intelligent iron founder could supply as efficiently as can the maker of steel. There is a large amount of work now being made in steel which good foundry practice could have saved for cast iron. The engineer who has once been disappointed is not apt to blame the maker so much as the product, and so steel is specified where cast iron, through faulty practice, has failed. In its struggle to hold its own cast iron must look to advanced cupola practice for its mainstay. Every branch of the iron business is advancing with rapid strides. Our foundries must wake up to a relization of these conditions. Engineers are more strict in their requirements of cast iron, while founders are drawing closer specifications around the pig iron furnace men. They in turn are constantly advancing, and I believe in spite of statements to the contrary, that blast furnaces have never produced a better and more uniform product than they are producing to-day. The adoption of standard methods for analyzing and testing, the agitation for improved grading, prove the steady progress in those branches which are vital to future foundry success. Let us then look to our cupola practice, and see to it that in the general progress the very heart of our foundry is not neglected.

For your Buffalo Convention last year, I wrote a paper urging an advancement in foundry metallurgy, suggesting that time which was being spent on worn out topics be devoted to a study of advanced metallurgical conditions. With this thought in view I have studied the various cupola conditions most needing attention, and have presented to you a few of the conclusions at which I have arrived. I have again endeavored to clear away

some of the disagreements which fill foundry literature, and if I have at all succeeded, let me once more ask you to press forward in this investigation, remembering that the very existence of the cast iron foundry depends upon its meeting the advancement of steel with advancement of iron, the cheapening of steel with the cheapening of iron, and the improvement in steel with improvement in iron.

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CAST IRON.

BY PERCY LONGMUIR, MANCHESTER, ENG.

The term "Cast Iron" embraces irons possessing widely different properties. The pig iron of the chemist and the cast iron of the founder are, of course, synonymous terms, cast iron being to all intent and purposes remelted pig. Generally speaking, cast iron may be regarded as metallic iron, associated with varying amounts of carbon, the content of which is seldom lower than 2 per cent. In addition to carbon there are always greater or less amounts of silicon, manganese sulphur and phosphorus present in every variety of cast iron.

Other things being equal the mechanical properties of any variety of cast iron depend upon the amount of these constituents and the relationship they bear to each other. This combination may be such as to favor the production of a high quality iron, or it may be such as to produce one that is poor. High and low quality are terms of convenience rather than of exactitude, and every iron produced is applicable to some definite purpose for which its quality may be regarded as good.

In reviewing the constituent elements of cast iron the foremost and most important in effect is that of carbon. Though it can hardly be said that the presence of any one element definitely rules the quality of cast iron, yet this element closely approaches this position. In a large measure it is the amount of carbon present in any iron that determines its quality and the purpose to which it is adapted. With average grades of cast iron the total carbon present varies between 2 and 4.5 per cent. This latter amount is exceeded in certain alloys such as ferro-manganese or ferro-chrome, but these are instances distinct from the cast irons. The actual occurrence or mode of existence of carbon in iron is to some extent a controversial matter. To the founder, however, who must necessarily keep on the prac-

tical side of science, carbon is known in two conditions, these are as free carbon or graphite, and combined carbon or iron and carbon in a state of definite chemical combination.

Cast iron, whilst fairly strong in compression, is weak in tension. Apart from other contributory causes this low tenacity may, to some extent, be explained by the distribution of the free carbon which is familiarly shown in a fractured sample of pig iron. The flakes of graphite or free carbon when the cast iron is in tension, act as isolating media, and a series of these little cuts, as it were, offer a convenient route along which fracture may readily travel. With a compressive force these conditions are not so evident and consequently cast iron is well adapted to resist crushing forces. Naturally a high content of free carbon denotes a soft iron, but it is the amount of combined carbon that regulates the quality of any iron and determines its suitability to meet any specific purpose. This relationship of carbon and iron is shown to best advantage with the steels, and in all steel works practice a given content of carbon denotes that steel to be applicable to a certain definite purpose. For instance a steel of razor quality would never meet the conditions required from one of "axle" or "tyre," temper and vice versa.

Hence standards have arisen which in the case of ordinary iron carbon steels are of almost universal recognition. These may be briefly summarised as follows:

Class of Steel.	Content of Carbon.	Purpose.
Bessemer	0.20 per cent.	Plates, Sheets etc.
"	0.25 " "	Axle steel.
"	0.30 " "	Tyre steel.
"	0.50 " "	Spring steel.
Open Hearth	0.20 " "	Boiler plates.
" "	0.65 " "	Spring steel.
" "	1.30 " "	Tool steel.
Crucible	0.90 " "	Chisel steel.
"	1.10 " "	Large files, drills, steels.
"	1.20 " "	Turning tool steels.
"	1.40 " "	Saw file steels.
"	1.50 " "	Razor steels.

The utility of carbon standards so well shown in the foregoing table unfortunately cannot be carried to the same exactitude in the case of cast irons. But recognising combined carbon

as the controlling factor the following four percentages give approximate representations of the quality denoted by that percentage:

Content of Combined Carbon.	Variety of Cast Iron.
0.10 per cent.	Dead soft.
0.20 " "	Soft.
0.50 " "	Highest tensile strength.
0.70 " "	Highest transverse "

These figures relate of course to irons of normal qualities. The difficulties in fixing exact carbon standards for cast irons are great, owing to the complex character of the metal and the high content of elements other than iron.

From carbon to sulphur is a fairly natural step owing to a relationship often found between these two elements in a series of ascending irons produced from a similar grade of ore. Sulphurous irons, apart from other drawbacks, are generally speaking "hard." This hardness and the relationship just spoken of may be found in the fact that high sulphurs usually accompany high combined carbons. A glance at the following series of ascending irons will illustrate this feature:

Number of iron	1	2	3	4	5	Mottled	White
Combined Carbon	0.50	0.60	0.80	1.10	1.30	1.80	3.00
Sulphur	0.02	0.02	0.04	0.08	0.11	0.15	0.20
Silicon	2.50	2.30	1.80	1.50	1.20	0.70	0.30

When producing iron in the blast furnace the lower temperatures favor the production of sulphurous irons, high in combined carbon and correspondingly "hard" or "white." These conditions are intensified if the slag be strongly acid, and are restricted if much manganese be present, sulphur in the latter case combining with the manganese, forming a slag of manganous sulphide. These conditions are interesting to founders in that the cupola furnace bears a certain analogy to the blast furnace.

With the cupola slow melting, accompanied by a low temperature, yield conditions which favor the taking up of more sulphur from the coke than is the case with quick working at high temperatures. An interesting increase in sulphur resulting

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from three remeltings is shown below, which, by the way, is not given as representing first-class melting practice.

	1st melt	2nd melt	3rd melt
Sulphur %	0.04	0.10	0.20

Phosphorus appears to have little effect on the combined carbon, and in a series of ascending irons this element usually remains fairly constant. To some extent it lightens the appearance of a fracture and has a slight hardening effect on the iron with which it is associated. From a foundry point of view phosphorus is not nearly so harmful as sulphur, and is less of an evil to the iron founder than the steel maker. Phosphorus in cast iron promotes soundness, increases fluidity, and with it the capacity for taking and retaining the sharpest details of a mould. Castings such as machine details, gearing and the like, which have a fair amount of shock to resist, may contain up to 5 per cent. phosphorus. However the general run of castings may contain up to 1.5 per cent., but higher percentages than this are only advisable for castings in which strength is immaterial.

Manganese increases the capacity of an iron for carrying carbon and by permitting the formation of double carbides of iron and manganese increases the hardness according to the content present. This hardening effect is, however, neutralized in the presence of high silicon.

Iron and manganese combine in proportions up to 80 per cent. of the latter, the product being the familiar ferro-manganese. With lower amounts of manganese, that is between 12 and 20 per cent. the product, is known as "spiegel" or "spiegelcisen."

Manganiferous pig irons are specially useful in foundry practice for mixing with others contaminated with an excess of sulphur. In this manner manganese may act as a softener, that is by effecting the removal of sulphur. Generally manganese increases the hardness and closes the grain, and hence is valuable in castings that have to be finished up dead smooth. With an iron in which silicon and sulphur are normal from 1 to 1.50 per cent., manganese will do all that is desired. Of this quantity a certain amount will be oxidised, which, varying with

furnace conditions may reach a total of 40 per cent.

Silicon is present in every variety of cast iron, and owing to its effect on the formation of combined carbon has been conveniently regarded as a ready means of controlling the quality of an iron. Silicon acts indirectly as a "softener" by producing conditions which favor the precipitation of carbon in the graphitic form, and other things being equal results in an iron, the softness of which depends upon the extent of this precipitation. Hence the silicon contents of various irons offer ready means for the adjustment of mixtures, and consequently there have arisen silicon standards. In general practice these standards cover the percentages of silicon from 0.5 to 2.5, ranging from castings such as cylinders and valve bodies down to soft castings, pulleys and the like. The influence of silicon on cast iron has been very fully investigated by Professor Turner, of Birmingham University in England, and by Mr. W. J. Keep, of Detroit. The following table is a summary of Professor Turner's results:

	Content of Silicon per cent.
Cast iron yielding maximum hardness	0.60
" " " " crushing strength	0.80
" " " " density in mass	1.00
" " " " crushing, tensile, transverse strength	1.40
" " " " tensile strength only	1.80
" " " " softness and general working qualities	2.50

The utility of silicon standards is shown in the foregoing table, and for general purposes a mixture figured on the content of silicon alone will give a reliable result. But it must be remembered that silicon acts indirectly, and that it is the combined carbon that rules the destiny of any iron. The relationship of silicon and combined carbon are shown in the analyses quoted earlier in this paper.

Very briefly the elements present in every variety of commercial cast iron, have been mentioned, and in addition to these already quoted the number may be increased by the designed or accidental presence of other metals, such as aluminum, copper, titanium, chromium, etc. Therefore the simplest variety of cast iron is necessarily of a complex character, the physical proper-

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ties of which are dependent upon the relationship these constituents bear to each other.

Of these constituents there are never less than seven present, or if we regard cast iron as a single metal, contaminated with foreign elements, we then have a body of iron associated with greater or less quantities of other six dissimilar bodies. That is to say iron is the matrix, and through this are distributed—as fruit through a cake—the other ingredients. Questions naturally arise as to the mode or manner of this distribution. Does the element in question penetrate the iron evenly and as an element?—if so my illustration of the fruit through a cake is inadmissable. Or is the element distributed in patches, as an element, through the iron? That is to say, do particles of iron, particles of manganese and particles of sulphur exist in contiguity, and as free elements? With the one exception of graphite, practical experience would not confirm such a supposition. On the other hand do the elements form definite compounds with portions of the iron in which they are held, and in the cold solidified metal exist as definite chemical compounds? A further point also occurs under this head, and that is as to the manner in which enormous physical changes are produced by the presence of exceedingly small amounts of foreign matter—sulphur forming a familiar example of this effect of traces. These and like questions lead one into a maze of scientific theory and speculation. Therefore the following fragmentary jottings are merely suggestive, and not in any sense conclusive.

In viewing the seven constituents that together form cast iron, it is evident that one, graphite, does exist in a state of freedom—that is as a form of carbon pure and simple. It has a mechanical effect as shown earlier, and it produces softness in the iron indirectly by reducing the amount of carbon available for combination. Graphite, therefore, having only a mechanical effect, can only act within fairly well recognized limits. But it requires no great stretch of imagination to realize in part the latitude in character offered by the remaining six constituents. Carbides of iron and manganese, silicides of iron, sulphides of iron or of manganese and phosphides of iron interspersed through free iron offer a range of latitude, varying ac-

cording to the degree of the penetration of the iron by the compounds. In this manner the effect of mere traces may be followed. Sulphur in suitable combination with iron or manganese in the form of a brittle sulphide, will occupy an area out of all proportion to the minute quantity of free sulphur originally present—the trace thus becoming enormously multiplied, and its effect carried to a far greater extent than any possible by the element in its free state. The energetic effect of small amounts of combined carbon may be accounted for in this manner and with an increasing content of carbon a greater distribution of the carbide occurs and yields a degree of hardness proportionate to the amount of carbide present. It is evident however, that a point must be reached at which saturation occurs, that is to say, when the iron has combined with as much carbon, phosphorus or other element as it can hold—the intrusive compound then penetrating the whole of the metal and corresponding with the disappearance of free iron. That this is the case has been very clearly and forcibly demonstrated by Professor Arnold in his exhaustive researches on carbon on iron.

Further thoughts are also suggested in that each of these carbides, silicides, phosphides and sulphides possess varying coefficients of contraction and must necessarily possess varying points of crystallisation—that is to say, the compounds will crystalise according to their degree of fusibility and therefore crystallisation may extend over a wide range of temperature. Conversely on heating the more fusible compounds will naturally be the first to soften and liquify. Therefore at temperatures far below solidification point there may exist within the frozen metal pasty or semi-pasty particles of a readily fusible compound. Founders who have observed pig iron melting on the hearth of a reverberatory furnace or an ingot of brass in a crucible, will have noticed on exudation of these fusible compounds before the liquifaction of the pig or the ingot.

There must be then within a mass of cast iron containing say 93 per cent. iron and 7 per cent. of other constituents, many conflicting forces, and the question arises at what temperature is an equilibrium established. It is evident that in large castings these internal forces are intensified by the unequal cooling from outside to centre, and that in a mass so cooling each rise of

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temperature towards the interior will represent a more or less distinct state of strain, but as the outside crust freezes the internal strains are imprisoned and the question again arises when is an equilibrium established.

These thoughts are of interest chiefly in the case of castings which are employed in positions in which temperature plays a part. It is within every day experience that occasionally a casting successfully treated hydraulically will fail when put on steam trial. May not this failure be due to the presence of compounds which are affected by the temperature of the steam? Imagining for one moment a solid consisting of several dissimilar ingredients distributed with more or less regularity through a common matrix, and we have a fair idea as to the structure of solidified cast iron. On the application of heat an expansion occurs and the more fusible areas distributed through the iron begin to soften and so destroy the continuity of the mass, rendering it liable to rupture by shock. Assuming that the temperature be too low to soften these compounds, but that it be sufficiently high to modify their structural arrangement, we then have a possible explanation as to why in certain cases a casting will resist a definite pressure applied by means of cold water, and yet will leak on a similar trial by steam.

Temperature and pressure seriously affect the working life of any casting, but generally speaking iron castings are not subjected to extremes on either hand.

Further than this it is usually the custom to design castings of greater bulk than that theoretically demanded in order to secure stability. This excess of bulk forms in most cases a reliable factor of safety, allowing the casting ample margin to efficiently meet the usual working conditions. It is of course abnormal results that direct attention to the possible combination of the constituents of cast iron in either beneficial or adverse forms.

The writer had hoped to illustrate this paper by a few micrographs and typical cast iron, but regrets that the available free time precluded this.

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SHOP TOOLS AND RIGS.

BY JAMES A. MURPHY, ERIE, PA.

Among the greatest economizers in our modern shops are properly designed tools and rigs, and not enough attention is usually paid to this end of the business. I do not mean to speak of such special foundry machinery as is usually procured from foundry supply houses, but those indespensable tools of our own "get up" for lifting and conveying our molds and material and the rigs we use for making our molds in sand and loam.

Aside from first class management, the design and equipment of a shop is the greatest factor in cheap production. No shop with pretensions to being modern, should be without one or more travelling cranes, but these should be supported by a system of auxilliary lifts along the sides of the shop. That travelling cranes are in many places a detriment to cheap production instead of an aid is partly because of this omission, and partly because many places do not know how to work them to the best advantage. It is a patent fact to all close observers that in shops having the best equipment, molders are kept continually waiting for lifts. Many reasons and excuses can be given, but the principal one is that our own inventive abilities have not kept pace with the times. Our flasks are designed without any thought of quick handling, and our lifting and hitching tools for the most part remain a relic of 30 years ago.

When a journeyman I worked in some large shops where only one set of lifting chains were provided, and when they broke, which was quite frequently, because of illusage, the greater part of the shop's crew was idle, waiting until they were repaired, which took some time as in one or two instances the

blacksmith's shop was at a considerable distance.

That there should be two or more sets of chains of different sizes as well as plenty of hooks, slings, etc., the best managers

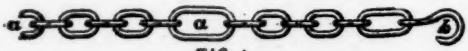

FIG. 1.

will admit. Fig. I is a style of lifting chain which I have in use,

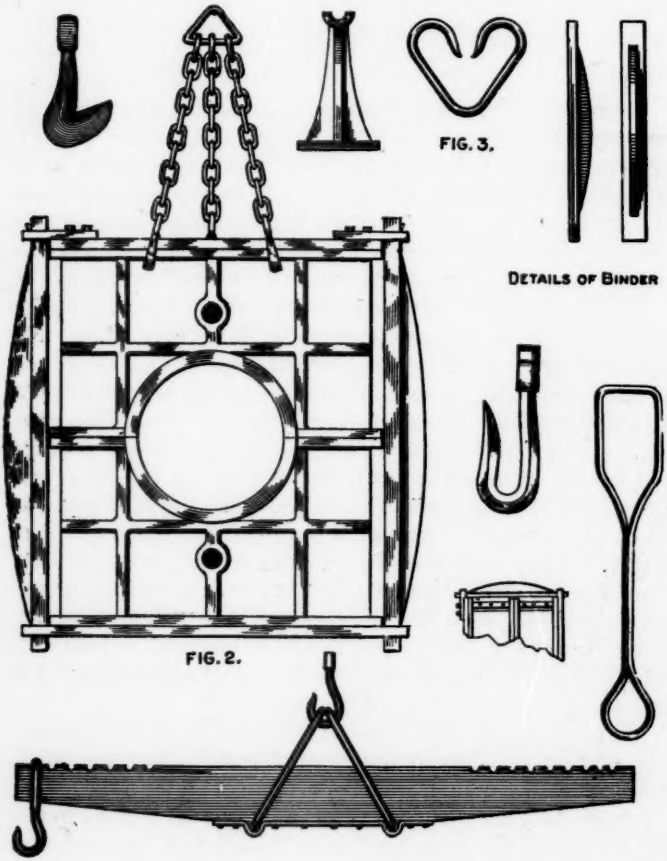

FIG. 3.

DETAILS OF BINDER

FIG. 2.

it adapts itself to four different lengths and gives admirable satisfaction. Two large links, (a) being placed at convenient points to allow for the doubling up and insertion of the hook (b). Fig. II is a sketch of the handiest lifting apparatus used in the foundry. Its easy adjustibility and quick action are its best recommendations. The sketch shows it hitched on a large cyclinder flask, (just the opposite from the way it is usually hitched on long flasks). When the flask is lifted off it is set so that the trunnions will rest in the horse at the right of the figure. The cope is then easily turned over by the men and the crane can pass along to further work. This operation when managed properly does not take more than a fraction of a minute.

The figure also shows a method of binding which as far as I am aware is a new departure. It does away with the necessity of placing long bolts in bottom and top of flasks, and then screwing them up with binder in position. The cyclinder flask shown has no bars, although the bore is 28", but instead an iron grid on top to which are attached wrough iron eyes for the binder to go through. They are also cast in the grate on the bottom. All that it is necessary to do is to push the binder up a little and let it fall into its place in the bottom plate. A few wedges here and there and it is secure. By this means a man will securely bind a large mold in a few minutes. By some other methods in vogue this would take hours.

There is another point about the cant-hooks that should not be lost sight of and that is where copes that are only partly rammed up or have cores hanging from them, so as to make a level lift with the chains tedious, they are just the thing, as they will catch equally well anywhere on the flanges. For lifting any castings that have flanges or other projections out of the floor they have no superior. They are perfectly safe and when in use a short time they are considered indispensable.

The shifting or changing hook is a valuable tool, and mostly all shops have some kind of an arrangement. As it is usual, when carrying cores, ladles, and miscellaneous loads on the traveller, to first set them down before transferring to another crane, much time is saved by using a proper changing hook. With a hook such as is shown in the sketch Fig. 3, it would be a quick and easy operation to lower off a load from the traveller to one

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of the side jib cranes. The hook has the advantage of a small first cost. No welds, easily managed, and thoroughly safe and serviceable.

The method of making flasks and the style of construction is a matter of great importance to most shops. I generally have a frame or outline of the part I want made by the carpenter, and the rest swept in the floor and cast open sand.

I append a sketch of a rather crooked "rig" for making the housing of a large vertical engine which was made in this way. Its general dimensions are about 13 ft. long, 4 ft. wide and 4 ft. deep. Aside from the cost of the metal, bolts and pins it cost me for pattern making $2.50, molding $14.07 and common labor $3.00, or a total cost of $19.57, which certainly is cheap for a flask of its size. The bottom plate was made in two parts so as to come in handy afterwards for core plates as shown in Fig. 4. The sketch itself is shown in Fig. 7 .

Speaking of core plates, how many of us are there who have

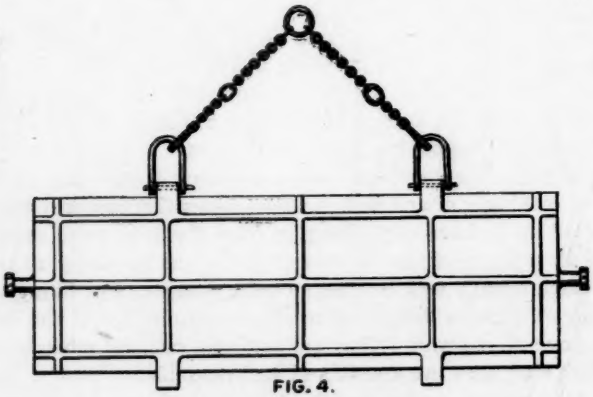

FIG. 4.

not seen the slip shod manner in which they are constructed in all shops, and how core-makers have to put chains around core box and plate to enable them to "roll over." Such a method is not allowable in the best practice except in extreme cases. A plate the back view of which is shown, accomplishes the purpose of saving the core box, and the rolling over is easier, far quicker,

and safer. The box will not slip from the plate if securely clamped as it should be in any case. In some cases I cast in steel trunnions on the ends and find they often come in very handy. In others I core out hole and thread it, so that a trunnion with a standard thread can be screwed in in case of necessity. Many cores are got out of shape by rolling over in the old way, besides marring the boxes. Plates should be well ribbed and strong enough to prevent springing. The plate shown is a time saver and has many advantages over those in almost universal use.

The most clumsy tool among foundry lifting devices is the more or less modern I beam, and the cast iron and oak beams will remain with us for many years to come. For very large work I prefer a well designed cast iron or cast steel beam, while for medium work I have a decided liking for the oak on account of its lightness and general handiness. An oak beam like the sketch I made some time ago, and it is a perfectly satisfactory tool in every respect. It will be seen that the beam is not weakened at any point by holes for the clevices, they being bolted to a wrought iron strap running under the beam and forming a perfect rest for it. It is secured to the beam with lag screws. A beam, hook and sling are shown in the illustration.

There are really few flask pins that give satisfaction. The device shown in Fig. 6 I have in use nearly two years on a set of

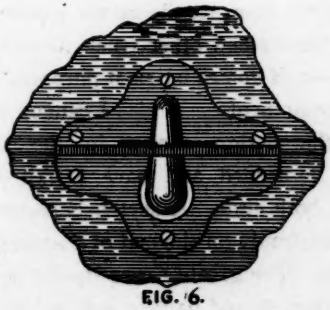

FIG. 6.

bench flasks, and so far is perfectly serviceable in every respect.

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It combines the handle pin and clamp, or fastening device, by simply pushing in a cut spike when the flask is closed, there being a shoulder on the pin for this purpose. The device is cast iron. I also employ the same style with slight alterations on all my wooden boxes with very gratifying results. The flask has not to be cut to put them on as they are simply screwed to the side. They are very quickly put on and the molder never has to take his lifter to pick the dirt out of the holes.

There could be many other things said on this inexhaustible subject which the limits of a brief paper of this kind necessarily curtails. "Repeat moulding" in loam and sand, and special rigs for rapid molding. I may in the near future make the subjects of another paper as these matters are very interesting to foundry managers, as it is in these particulars that the ingenuity and real ability of the foundryman is shown. The best pusher is he who gets up good "rigs," not for one particular job, but for everything. Never think you have completed making improvements, there is always room. On many classes of work the foreman must be an engineer of no mean ability, and if he does not know his business, it will tell in construction work quicker than any other branch of the foundry management, excepting, possibly, the mixing and melting of iron.

It is a common thing, in many shops, when a large cope is to be kept above the floor, to pile up the whole place with small wooden boxes, barrels and other truck to support it. A very light and handy set of horses for such purposes should be a part of every shop's equipment. I cannot imagine anything cheaper than the design shown in the sketch, as only some old pipe is needed and have a cast iron flange run around them on both ends. A sketch is shown (Fig. 5). The clutch hook is also handy on the end of a strong chain for lifting awkward castings. The greatest care should be taken of chains and hooks, and they should be kept safe by occassional annealing. The loss of life which in many cases is akin to murder is due in a great measure to this carelessness. Well designed lift-

ing apparatus is a money maker, and the greatest of diligence should be exerted in keeping it in good and proper order.

FIG. 5.

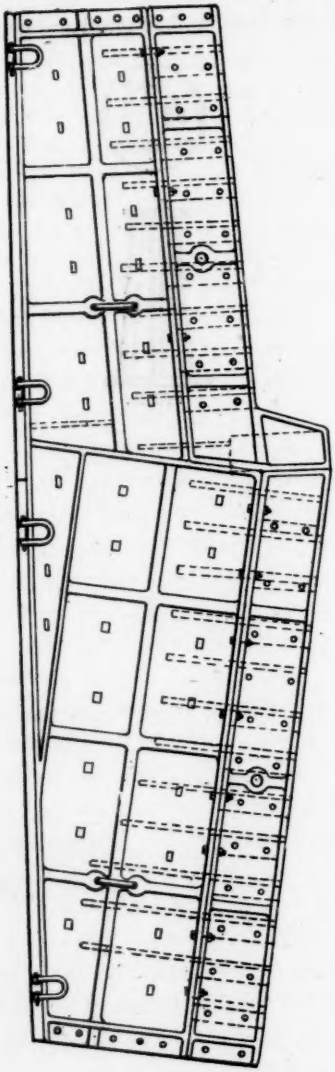

FIG. 7

Journal of the American Foundrymen's Association.

VOL. XI. JUNE, 1902. PART I.

FOUNDRY ACCOUNTING.

BY J. G. STEWART, NORTH ORMSBY, ENGLAND.

In compiling this paper I have started with the assumption that all those who read it are ignorant of the inner workings of a foundry or general engineering shop; that their knowledge of what goes to make up a cost account is nil. Therefore, I hope a little liberty in the introductory portion of the paper will be granted me.

Cost accounts and the important part they play in the success or failure of a business, do not always receive the consideration they are entitled to, but are looked upon as a conglomeration of figures and often not worth the paper on which they are detailed. In fact the idea prevails with some men, to quote from actual experience, "that concern which will not stand mismanagement is not worth tackling."

To every business man in the foundry line it will be apparent that he should become familiar with the commercial as well as the practical branch of his business, and as a great deal of his success depends upon close attention to detail, he very soon realizes the importance of the cost department. Here is the key to a financial success, and to a large extent the prosperity or failure of a firm is traceable to the importance they attach to the question of cost accounts.

There are many, I am sorry to say, who do not pay any attention to the cost of production, but go on in a slip shod way, until they find themselves gradually ousted from the place they once held, owing to their lack of business ability. There are a few who have striven hard to keep afloat by close attention to business, but have failed through lack of capital. These cases are few, however, in comparison with those that have had the means at their disposal and have yet failed.

Business has almost become a fine art, and among the foun-

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dries especially, this is so. The time has now come when foundrymen should bestir themselves and tackle the cost question in real earnest. There are many even in this advanced age, who never ask themselves—"am I paying too much for this, that, or the other," nor do they try to ascertain which class of work pays and which does not; so long as a profit is shown, that is all that they require.

The economical and successful working of a foundry plant is the result of close watching. The purchasing of materials in the right market and at the proper time, watching the market reports, exercising judgment and buying accordingly; the practical, theoretical, and technical education and business ability of the management, the accuracy of the estimating and costing department, the co-operation of the officials, foremen and workmen, all tend to the success of an undertaking.

The cost department is essential for the successful working of a manufacturing business. It is possible in a properly managed shop for the cost of every article to be detailed and tabulated from the small castings of a few ounces to the monster pieces weighing 30 or more tons.

With the right man at the head of the cost department, who is thoroughly acquainted with the requirements of a foundry, working amicably with the heads of the moulding shop, information can be readily obtained and accurately tabulated.

If the principal of cost-keeping was better understood we should have fewer cases of failure to report. Huge successes probably would not be heard of so often, as a keener competition would result and it would then be a question of quality and workmanship plus influence, rather than price that would secure the largest share of work.

It will be difficult to lay down hard and fast rules to be followed by firms, big and little, but the system suitable to a large concern can be so modified as to be applicable to a smaller one.

To enable us to compete favorably in the open market we must see that our shop is well placed, well equipped with modern labor-saving appliances; comfortably warm and light in winter, and well ventilated in summer, facility for handling traffic by rail, road or water; the means for storage of boxes, loam plates, etc., with due consideration to available land for extension. Good

management, and an expert and efficient office-staff, and the reward of success is certain.

Having arranged the location and equipment of the foundry we turn our attention to the question of a foundry manager in whom should be vested power to enquire into all matters appertaining to his particular department. The qualifications for such a post should be, a good technical knowledge, added to a practical experience, not only of moulding and core-making in the various classes, but cupola practice and metal mixing; these combined with a sound knowledge of the commercial branch of the business, and a firm, yet kind manner.

The proprietors of the small shop, I am aware, has to be his own manager and foreman, too, but even he can take the principle of the foregoing paragraph and learn his lesson well therefrom. The foreman, while possessing a good practical knowledge and experience in the art of moulding should be able to portion out his work to advantage, and have an idea of the value of the core-making and moulding of each piece. He should be kept free from account books of any kind, leaving him at liberty to superintend the men and direct the work of the shop. To the foreman we look for the output of castings, and only when some serious increase of expenditure is incurred need we trouble him about the cost accounting.

The clerks or commercial men should be made specialists in their particular line, for there are many things in a foundry with which they must become familiar before any reliance can be placed upon their work. With some firms, too much notice is taken of the officials in the general office respecting the working of the foundry. If these could be persuaded to go into a casting shop when a big job is being poured, they would vote it a filthy place, and not fit for them to be in. On such individuals is sometimes, however, bestowed the important work of making up costs and estimates, and to such, a foreman is expected to bow and scrape his allegiance and pour out his own knowledge and wisdom for the benefit and probable promotion of his hearer, and the possible downfall of himself. Kjrk in his book on "Cupola Practice" mentions the fact "that metal is melted in the office with less coke than it is in a cupola."

Therefore the office-man for the foundry department should

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be selected from those who know their own business and the requirements of a foundry. A man who devotes himself to studying his work, who takes a delight in all things appertaining to the foundry, who spares neither time or money to thoroughly master every detail in founding, such a man is a credit to the firm and a source of strength in the upbuilding of a business, for reliance can be placed on his work and methods.

Let us start with the Commercial branch of the business first, follow it step by step and witness the relative workings of the commercial and practical parts, and we shall see how, in a properly organized establishment and under capable management, the whole concern works smoothly, wheels within wheels, and at the year end a balance sheet envied by many, equalled by some, but surpassed by none, is the outcome, always allowing that you have men engaged who not only know their business, but practice what they know. The commercial staff must be awake to the duties required of it.

Suppose an order has come, and the drawing are in the hands of the draughtsmen. It may be that dozens of castings are required to enable the work to be completed. We require some system whereby we can keep track of the job as it goes through the various shops.

Therefore the draughtsman's first aim should be to obtain a distinguishing number or mark, to ensure his being able to readily turn to the drawings or tracings in question.

Now, in a methodical office, the original order, after certain particulars have been noted, would be handed to the person in charge of the cost department, who would make an entry in his Order or Contract Number book. Here we shall find the number assigned to the work under consideration is, say No. 1. The date of the order, the firm's name and probably address for whom the work is required, with any other necessary particulars are entered. The original order is also duly numbered (No. *1*) to correspond with that in the order book. The order is then passed on to the clerk in charge of the "outwards" traffic and "outwards" invoices. He in turn makes the notes requisite to his department, where, when, and how delivery is to be made, amount of contract, and any special shipping or erection marks. The order now goes back to the management where it is retained.

Any alterations or additions to the order should be notified to those whom it concerns by a typewritten slip, in fact, all instructions should be typewritten. In some concerns it is customary to send typewritten slips to the head foreman in each department notifying them of the receipt of an order, giving the office contract No., and any special instructions necessary. By this means the whole of the officials are kept informed of what is going on, and are anxious that their's is not the department to keep an order waiting. All are on the look out, and as soon as the castings or whatever class of work it may be, make their appearance, the work is at once proceeded with.

To return to the draughtsman. He has obtained the distinctive number (No. 1) and he proceeds with the various tracings, taking care that before they leave his department they are duly marked. The pattern-maker commences his work, and as soon as he has any patterns ready for the foundry they are stamped 1, a gummed label is stuck on, one which will be detailed the Contract No., name of the particular castings and number required. The pattern-makers enter the number of hours spent preparing patterns for the different parts, and specifying the particular part, on their timeboards each day.

The material used on the job is entered on a sheet, a supply of which is given to each man. (All timber, etc., is charged to the pattern-shop account, through what is termed "the impersonal accounts" which is described later). When he requires timber for say Bedplate Order No. 1, he makes the necessary entry as under:

Wood Sheet, week ending.....

Board No. 333 Name.....

Contract or Order No.	Particulars.	Description.	Length ft.	Length in.	Width in.	Thick. in.
1	Bedplate	Yellow Pine	10	0	6	1
1	L. P. Cylinder Cover (Loam Board)	do	7	6	5	¾

The foreman pattern-maker in checking over the time-board and wood sheets, if he is up to his profession, can readily detect any discrepancy in the entering. As the castings are made, or as the moulding and core-making progresses the workmen enter their time to the castings, etc., on which they have worked, stating the order number in all cases.

The foundry weighman, whose duty it should be to obtain a detailed list of castings made the previous day, has all the required information given to him by the workmen, he weights, and marks (in white paint) the order number on each casting, and away they go to the machine shop to be dealt with according to the laws of the establishment, every man bearing in mind that he has to furnish a record of the time spent on the various parts which go to make up the Engine, Machine or whatever the work may be.

Daily list of Castings Made Monday, May 5th, 1902.
Week Ending May 10th. 1902.

Order or Contract Number	Number of castings	Description of castings	Pattern shop order No.	Weight T.	Cwt.	
1	1	Bedplate	22	7	10	– –
1	1	L P. Cylinder	7	5	3	2 14
3	20	Fire bars	5	–	6	0 14

Now it may be asked how do you keep a record of all this? Simple enough. The draughtsman keeps a record of all the tracings that have gone into the pattern or machine shop. The foreman pattern-maker as soon as he has the patterns ready issues an order (the counterfoil of which he keeps) on the foundry for so many castings.

Take the main bearing bushes for example. The foreman moulder gathers from this that he has 6 castings to make off one pattern, and 5 off the other, then the pattern is to be altered for the 6th. The clerk whose duty it is, keeps a record of the castings made, cleaned and weighed off, and makes a note to that

Pattern Shop Order.

Remarks:—

Pattern returned

(Name of Town) .....Date.....190 No. P 22

To Messrs.....

.....

Please supply

1	Bedplate	Contract	1
6	Main bearing Bottom Bushes	"	1
6	do Top "	(5 off then alter) Contract	1
250	Firebars - - - - -	"	7

For (name of firm)

Signature or initials.....

effect on the original pattern-shop order, or in any special book kept for the purpose (when the patternshop order is marked it saves unnecessary labor and expense).

When the requisite No. of castings have been made off a pattern, and, as far as can be ascertained, are pronounced sound, the pattern is sent back to the pattern-shop and a note made in the order book of the date on which it is returned. Should more castings be accounted for than are required then enquiries should be made and a satisfactory explanation asked for.

One of the leading rules of the establishment should be "promises must be fulfilled," and if all officials have this ruie impressed on their memory, everything will go smoothly, but so soon as the management relaxes its hold or gives way on small details, the business will soon begin to fall away. A firm with a reputation for keeping to promises will ultimately succeed.

The next question is that of the timekeeping system. To enable us to arrive at the cost of labor on any particular castings we must have some means whereby a record is kept of each man's time, and the particular piece on which he has been employed. The timekeeper is, therefore, supplied with certain information sufficient for his purpose, including the firm's contract numbers. As each man's time-board is returned to the office, giving particulars of the jobs and order number, with the number of hours spent on each. The day's time is chcked over and next morning the boards are submitted to the foreman to certify them as correct, after which the particulars are entered on specially ruled loose sheets, and as each order number comes before the notice of the timekeeper, he having already the information at hand is able to detect any error on the part of the workman respecting numbers, the nature and name of job having already been certified.

I am bound to admit that in a number of concerns the signing of boards is a mere matter of form,but in a properly organized establishment it is anything but a formality. Insist on the correct details being sent in, return the time-board for correction, and if repeated mistakes occur inform the foreman of such gross carelessness and the men will soon see that they and the office must work together in this respect or there's going to be trouble. The loose sheets referred to are ruled as under:

WAGES. Week ending.....

Board No.	Workman's Name.	Rate of Wages.	Particulars. Job	Order no	Su	M	T	W	Th	F	S	Total hours.	Abstract account.		Amount of Wages			Hospt'l &c ded'ct's
Loam	Molders																	
1	John Smith	38	Cylinder cores	1	–	9¾	9½	–	–	4	–	23		16	6			
			Bedplate cores	1				9½	3	–	–	12½		9				
			L. P. Cyl. cover	1					6½	5½	–	12		8	7			
			M. P. piston	1							5½	5½		3	11			
												53				1	18	0	£2

(We work 53 hours a week here, and I have given the illustration as such.)

The time, day by day, is recorded, with the name and order number of job. At the week end the total time spent on each item is made, the grand total of hours for the week filled in and the timekeeper's duties with the sheets for that particular week ceases. In some works it is customary for the timekeeper to complete the wages and make the abstract for cost purposes, but where a sufficient staff is kept the £ s. d. should be worked out and the wages paid to the men by a separate department. The loose sheets enable several hands being set on, preparing them for the final of the pay as well as the use of the cost clerk.

The total time is first checked over, then the gross amount of wages due filled in the proper column. The sheets are then passed on to someone else who fills in the abstract or detail portion, which total amount should agree with that of the gross amount. By this means the workings are proved, and enables the additions to be made with greater speed, one column checking the other.

As soon as a number of sheets are ready and in numerical order, they are passed on to the cost clerk or his assistants who proceed to abstract the details, debiting each order number and each piece of work with the amount of wages expended on it.

If there should be a pattern shop or machine and fitting shop in conjunction with the concern, the amount spent in each branch should be stated.

While the costing department is busy abstracting the wages account, let us go for a while to the foundry and see what hints and ideas we can pick up. While allowing that the foreman moulder must to a large extent be responsible for the amount of labor employed in his shop, there are many little details needing attention to which he cannot reasonably be expected to pay heed, so a superintendent over the laborers is appointed and to him we must look to successfully manage the unskilled labor. He should be a man of energy and perseverance, know how to distribute his men to advantage, always be planning ahead, and as far as possible have his men and work so arranged that a good start is made first thing in the morning. Let him feel that he is responsible for the successful handling of the men, and he will soon appreciate the confidence reposed in him, and will be wishful to

work harmoniously with the office and render all the assistance possible to enable an accurate return being made of the unskilled labor cost.

In a shop employed on big heavy work, the moulders will, doubtless, utilize the time of one or more laborers, in which case the time should be charged to such particular pieces. Laborers' time on the loam floor should be treated similarly or charged as loam-floor labor, so that the loam work is debited with its proportion of labor for each week, but general shop labor should be distributed proportionately over the general green and dry sand work.

Where overhead travellers are employed the cranemen when occupied for any length of time on one particular job, should charge the time so spent to that job, the remainder of the time to be divided over the jobs in the shop which require the use of the crane.

Let us now consider one of the vital parts of founding, viz, the cupola and the charges relative thereto. The cupola and its peculiarities is only beginning to receive due consideration, and we are fast approaching the time when foundrymen will be willing to admit that it is only by judicious treatment and carefully weighing of the burden that we obtain the best and most economic results. Unless we resort to the weighing of the charges, how are we to determine the cost of any one or number of castings. In compiling details for cupola costs we must take into account:

Cupola men (wages).

Laborers unloading pig iron, scrap, etc. (wages).

Fettling required for repairs to cupola; daubing of ladles, etc.

Repairs for renewals of cupola tools (wages and material).

Coke to form bed in cupola.

Quantity and grade of iron charged, also coke and limestone requisite for each charge.

The wages can be obtained week by week from the wage sheets, the fettling used for cupola and ladles from the man

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		£	s.	d.	Total		
Wages	Cupola men's wages	–	–	–			
	Blacksmith's " repairing tools	–	–	–	–	–	–
fettling	Material used for repairing tools	–	–	–			
	Fettling for cupola, etc.	–	–	–	–	–	–
fuel & flux	Wood	–	–	–			
	Coke in bed	–	–	–			
	do charges	–	–	–			
	Limestone	–	–	–	–	–	–

Tonnage etc. of Pig Iron and Scrap charged

T	cwt		Grade	Brand	Purchase price			
–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–
–	–	–		Total value of Iron		–	–	–
–	–	–		less ⅌ melting loss.				
–	–	–	Credit for gates, risers, metal poured on floor, waster castings		@ Scrap price.	–	–	–
–	–	–	Total of good castings as per weighmans detail lists or sheets.		Value of iron in same	–	–	–
			Total cost of producing T....Cwt....good castings					–	–	–

whose duty it is to keep them in order, the coke, iron, etc., from the man charging the furnace, who should be provided with printed charges sheets, a ruled slate or board on which to state the contents of each charge as it is put on. If the records thus obtained are properly tabulated we shall be able to trace the mixture of irons used for the various castings. At the end of the week the particulars are tabulated and the cost of melting ascertained:

The question of coke consumption for stove fires is a sore point with some iron founders, but a real business manager will seek to know where the leakage is, and have it remedied.

Foundry supplies generally, are a source of annoyance, especially in a works where the foreman does not exercise a little judgment, and enquiry before giving orders to his men. Here again the manager soon puts matters right, and we are able to charge each job with the proper number of chaplets, etc., or the different classes of work with the proportion of supplies used, or the work generally with the tools procured for general use, giving credit to the supplies department.

To facilitate the putting together of figures for a weekly or monthly return, the fettlers should, as far as possible, clean off each day's work as it is brought out of the foundries. If this were insisted on there would not be the number of lost castings nor the extra labor entailed in hunting them up or possibly having them remoulded.

To arrive at the cost of any piece of work we have to account for the amount expended as per wages detail, as well as iron, etc., used, making necessary allowances for melting loss, coke for core and mould drying, fire clay ganister and fire bricks for repairs for cupola, and numerous items with which foundrymen are acquainted, all must be taken into account, and when properly managed the cost accounts will show exactly what has been expended to produce certain work. I have known cases where in making up an estimate, one ton of raw iron was supposed to produce one ton of molten metal in the ladle. The coke for the bed of the cupola and charging was guess work and so was everything else. Needless to say the firms referred to were only in business a short while, from 12 to 18 months.

There are many small foundries that have not work for,

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and therefore cannot afford to keep a competent cost clerk fully employed, still the principles laid down, if followed out, should be a saving of cost to the foundryman. I admit it requires close attention to keep things jogging along smoothly, but attention to necessary small detail always recompences for the labor bestowed on them. The things requiring close attention are almost innumerable, and it requires a staff of officials that know the business thoroughly and are able to use the facts and figures which are ascertained in the ordinary routine.

In all enterprises there are certain fixed or establishment charges which have to be accounted for, and due allowances made for them in estimating, and for their proper distribution over the cost of saleable articles turned out. Among the many items which have thus to be accounted for are: Formation expenses; rent, rates and taxes; salaries to officials, etc.; insurance (fire and accident); gas and water; printing and stationery; postal charges; advertising; maintenance and repairs; depreciation in value of fixed plant and machinery; loose plant and tools. The depreciation is dealt with by the accountants at stated periods, say every 6 or 12 months, the other items being detailed in what is termed the "Impersonal Ledger." In this we debit the items mentioned under the heading of Establishment charges (with the exception of depreciation) also the total amount in wages paid to workmen, the different brands of pig iron, cast iron, scrap, coal and coke, sand, limestone or other fluxing materials, coal dust, blacking, plumbago, chaplets, in fact everything chargeable direct to and for the sole use of the foundry. In every case the weight or number, with purchase price, might, with advantage, be stated.

The details are procured from the invoices "inwards," on which the prices as per contract, the money calculations and the weights are first certified as correct. (The weights are obtained from the weighman's goods-received book). The weight and amount to be debited to each account is also specified.

FLASKS AND LOAM PLATES.

This portion of the subject is a difficult matter to settle satisfactorily to all parties. My own idea is to open an account in the cost ledger, debiting the said account with the cost of

making, charging all labor in connection with the making, plus iron, coke, etc., giving credit for them at cast iron scrap price, carrying the difference to profit and loss account. If in the case of a new shop where the bulk of the flasks, etc., are made at the commencement, the difference could be divided over a period of say 3 years. By this method the value of the stock will be kept nearer its real value as an asset, and should the firm through any unforseen circumstance be compelled to give up business and the plant sold, the amount realized and the value as per books will be very nearly equal.

Some firms I know, enter their stock of iron flasks and plates at almost the same price as saleable castings, which is a misrepresentation of the value of the plant to say the least. Flasks and plates are not like machinery, which could probably be disposed of at very little below cost price, (I am speaking now of up-to-date machinery), but who would like to pay say from £4,10 to £6,10 per ton for iron flasks, etc., that are perhaps only worth 50 per cent.; we must also take into consideration the length of time some boxes remain idle. They are depreciating week by week until the rust begins to peel off, the metal becomes weaker and weaker, and yet some people at the year end take credit for them at a fabulous price. Is it honest I would ask you? when a special job comes in (one or two castings off) and special tackle has to be made. I should charge the cost of making the tackle to the job on which it is intended to be used, giving credit, as I say, for the iron as scrap. Then, say 12 months after the specials have been delivered to the customers, no enquiries for the same or similar goods are to had, break up the tackle and utilize the space for something else; you are thus turning to account so much capital otherwise laid idle.

Catalogues.—As can be expected, when a new works is being started, there are always plenty of firms on the look out for new business, consequently catalogues detailing sundry and various requisites, and labor saving appliances begin to pour in. These are a source of annoyance to some people and do not receive any attention. But to a firm desiring to succeed there is nothing so small, but some consideration might with advantage be paid to it. In my mind all catalogues and lists should be numbered, the supplies mentioned indexed, with the name and

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address of the firm and the number of the catalogue for reference. If this were done we should have at hand a ready index of everything in the way of foundry requisites. If a second copy of the catalogues could be procured and left in the foundry-foreman's office for his perusal, a few valuable hints might be obtained, besides who is better able to judge of the qualities and usefulness of an article than those who are in daily contact with and who use them.

New Hands.—When moulders and core-makers are being started, it would be a good thing if the foremen were to enquire whether the men have their outfit with them, (that is to say a trowel, cleaner, a 2 foot rule and a hand hammer; and in the case of a loam moulder a rat tail blackwash brush). This precaution would prevent a great deal of time being wasted by men perhaps going all around a shop to borrow something or other with which they ought to have provided themselves before seeking to start work in a new shop, and would no doubt be the means of the men taking more pride and interest in their work. This is perhaps a trifle at sight, but it adds considerable to the cost account to have to pay a man a few half hours looking for the ordinary tools of his trade. In addition he disturbs and annoys his fellows by his queries.

Finally our cost account is presented, the details being obtained as follows:

Skilled labor, etc. (wages) from abstract of wage sheets.

Material used in cupola and cost of melting—from cupola charges sheet, and labor return made weekly.

Supplies—as per priced list of supplies used, made up every week.

Timber for flask bars, gate sticks, scaffolding for loam work, etc.—as per pattern shop charges to foundry account.

Bar iron when obtained from blacksmith's shop—as per smith's shop charges to foundry account through bar iron sheets.

Plus percentage for establishment charges ascertained at stated periods.

The success of certain firms is astonishing, but if asked for the reason the secret will be found in knowing the cost of production, the attention paid to detail and the harmony in which everything and everyone work.

Journal of the American Foundrymen's Association.

VOL. XI. JUNE, 1902. PART 1

REDUCE THE APPRENTICESHIP PERIOD.

BY E. H. PUTNAM, MOLINE, ILLS.

In England, the apprenticeship term used to be seven years. What it is there to-day I do not know; but in America, four years constitute the generally prevailing term.

The conditions existing at the time that seven years was established as the standard justified, no doubt, that long period of service. Nor can it be doubted that progress in the industrial arts, together with advance in the general intelligence warranted the great reduction of the apprenticeship term when four years was adopted as sufficient.

It seems to me that the time is at hand for a still further curtailment. We have made greater advance since the establishment of the four year term than during all the previous history of the world. Any argument that was valid for the drop from seven years to four, applies now with manifold force for another large reduction.

Never before has the demand for skilled labor so greatly outrun that for common, or unskilled labor.

Sustained industrial prosperity depends as much upon supplying the demand for goods as upon the demand itself. If the industrial world take opportunity by the forelock, and so fulfill the prevalent conditions that make for permanence of the marvelous system that is rapidly enriching the people of America, there will be no chance for reactionary elements to gain an effective momentum.

The demand for product exists; all effort should be bent in the direction of supplying the demand.

The factors of the industrial system are inevitably reciprocal. Effective demand cannot exist without its correlative supply, and vice versa.

Now, the upward march of industry has, in large measure, lifted the world's work from the sphere of common labor to that of skilled mechanics. And the transition in this direction is now

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more rapid than ever before; and, but for the impediments that ignorance throws in the way of progress, there would soon be an end of all unskilled labor.

Why should any man harvest his wheat with a hand sickle, or plow his ground with a crooked stick? Why should any of the operations of the manufactory be abandoned to so low a plane as to dispense with the element of skill? Nay, rather, why should not every operation of the great industrial machine be so advanced as to require emulation and quick intelligence on the part of every human participant?

Cut the apprenticeship period in two, at the middle. Two years' application will do more toward perfecting a mechanic along modern lines than four years under the ancient regime, when mechanics were of the "all-round" character, instead of being limited specialists, as at present, and as the future will more and more insist upon.

The employe loses far more by loss of business incident to the protracted apprenticeship term than he can possibly gain from the comparatively large profit on the last two years of the apprentice's service. And the whole of society loses the possible increased wealth that would result from duplicating the army of skilled artisans every two years instead of every four. Throw into the balance the intellectual and moral gain of society that would spring from so great an uplift of the submerged, lower stratum of men, and, it seems to me, we have an accumulation of incentives to the proposition that heads this paper that should brush aside every thought of opposition.

Journal of the American Foundrymen's Association.

VOL. XI. JUNE, 1902. PART I.

TECHNICAL EDUCATION.

BY PROF. R. H. RICHARDS.

Another word on the preparation of young men for the foundry business.*

Demands for men in this work seem to be along two lines 1. Apprentices who hope to become expert molders and melters, and 2. Men who enter the business with the intent to become expert foundrymen.

It is of this second class that I wish to say a few words.

The modern metal works are finding it more and more necessary on account of the greater demands of the consumer, to get the right degree of hardness to suit the tool worker, of strength to satisfy the engineer, and of resistance to chemicals to prolong the life of the finished piece. They can no longer afford to ignore the chemistry of the process where a slight increase or decrease of an element may make or mar the result, nor can they afford to ignore metallography which by etched surfaces studies the arrangement of the crystals of the several compounds which go to make up the mass of the casting, and which by their size and arrangement indicate the favorable or unfavorable condition of the metal; nor yet can they ignore the pyrometric measurements by which they can follow the heats through the time of treatment and note the conditions which give more favorable or less favorable results.

The grammar school boy who has passed through the apprentice period has not had the training necessary for intelligently discussing questions of composition, structure, or chemical stability of the metals; the technically educated, while he may not have dealt with the exact questions that come up in foundry practice, has dealt with questions quite as complex, and his school training has largely been in the direction of developing in him breadth of view and quickness of perception, mental

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alertness and adaptability is important in keeping abreast of the modern march of improvement.

It is to say a good word for these men and to ask for them a trial that this paper is written, and it is the belief of the writer that not the young man only will be the gainer, but that the works which gets the right man with technical training will find great advantage therefrom.

Business men will always need to have patience with the school-trained man while he gets his special practical experience, just as they do with the apprentice who makes his blunders which have to be submitted to while he is learning. The school man's blunders will teach him something, while the apprentice may get no wisdom. In this time of many books, the school-man has an immense advantage in familiarity with the literature of the subject thus saving time in finding out what others have done, thus saving time in not repeating the disastrous experiments of others. He is also able to find suggestions for new work in his literature which may be as sounding words to the uneducated man.

In the iron and steel business, the school educated man has come to the front. Why should he not also in the foundry business?